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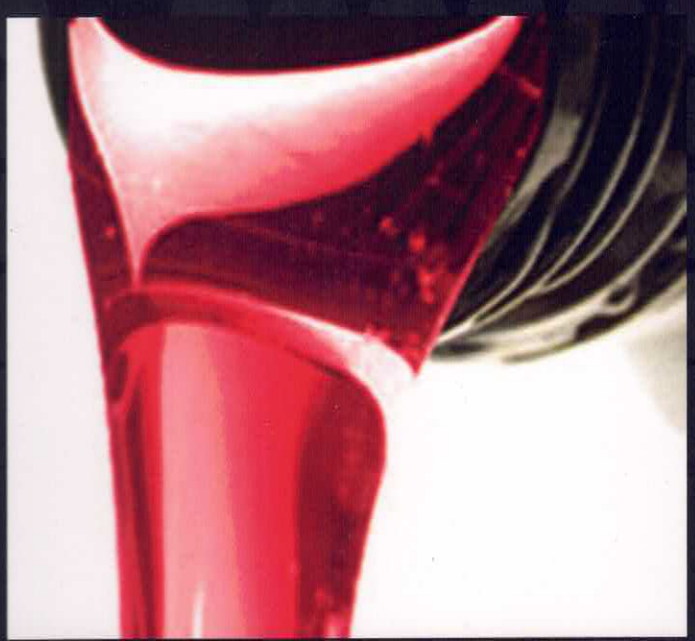
Technical Training Manual

Automatic Transmission Servicing



- Understand the importance of using the correct transmission fluid
- Explore the pros and cons of different transmission fluid change methods
- Learn why scan tools are important when checking transmission fluid levels
- Discuss why some OEM's claim that transmissions are now filled for life

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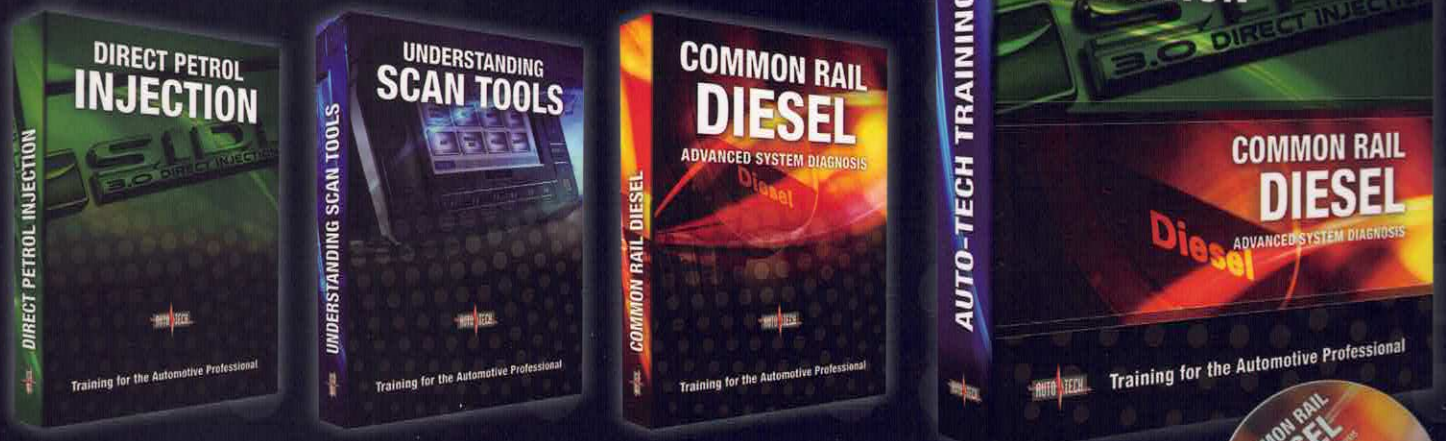

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LOOK FOR THESE SYMBOLS THROUGHOUT THE MANUAL

Note: *Indicates a point of interest*

Caution: *Indicates the risk of minor injury, special procedure or possible damage to a component*

Warning: *Indicates the risk of serious or life threatening injury*

Introduction

Automatic transmissions have increased in popularity since their introduction to Australia in the early 1960s to the point where nearly 60% of vehicles sold new today have them fitted. A workshop without the ability to service and diagnose minor faults on an automatic transmission risks losing customers and a profitable source of work.

The following charts depict the Automatic Transmission growth in popularity along with its evolution.

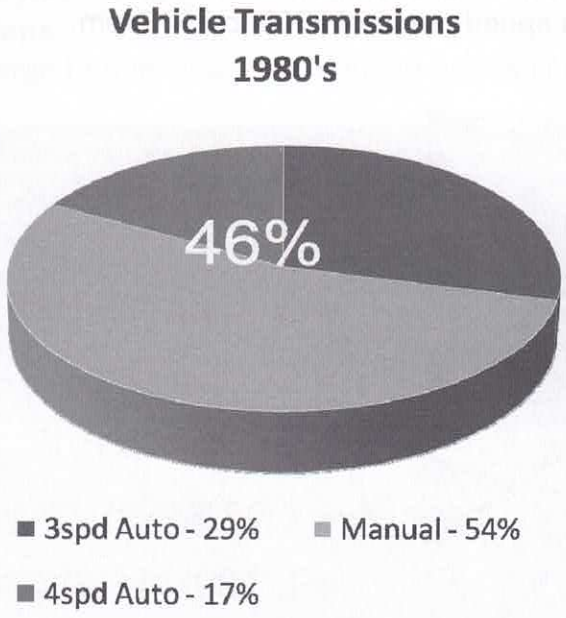

Diagram 1: Transmission type by year 1980's

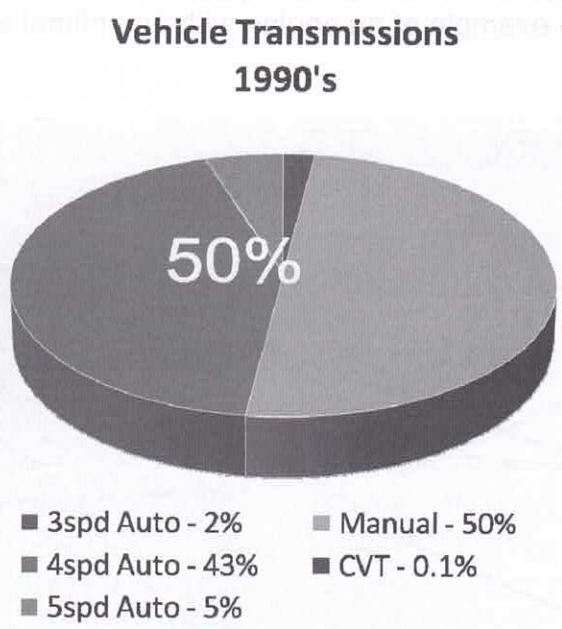

Diagram 2: Transmission type by year 1990's

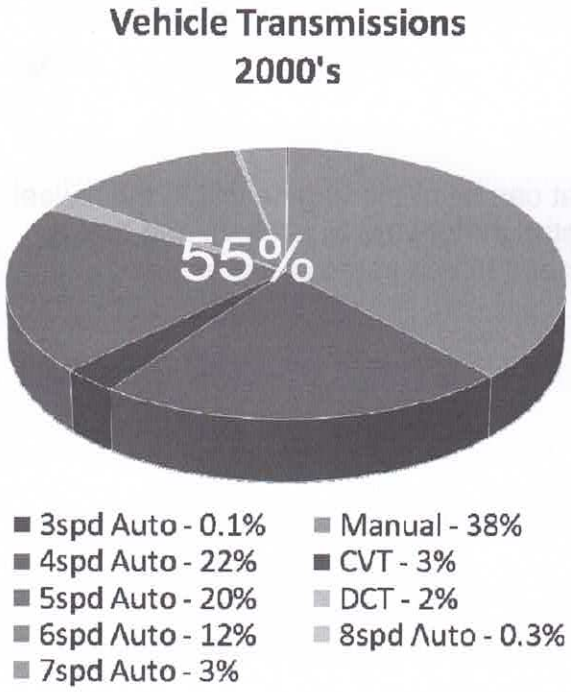

Diagram 3: Transmission type by year 2000's

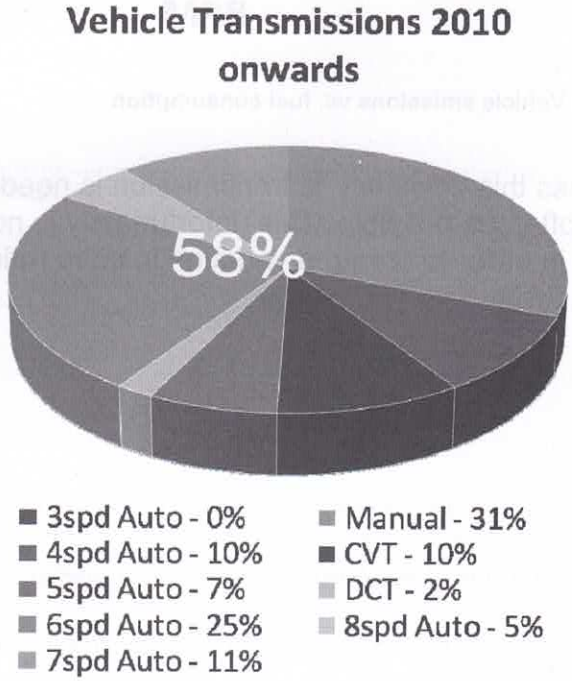

Diagram 4: Transmission type by year 2010-2013

INTRODUCTION continued...

The choice of transmission type for a given vehicle is based on 4 main considerations:

- Fuel Economy
- Emissions
- Driver preference
- Cost

All engines have a 'sweet spot', this refers to the engine speed range when an optimal combination of low fuel consumption is combined with low exhaust emissions. The graph below shows an example of an engine with an optimal engine speed range of 2000 to 2500 rpm.

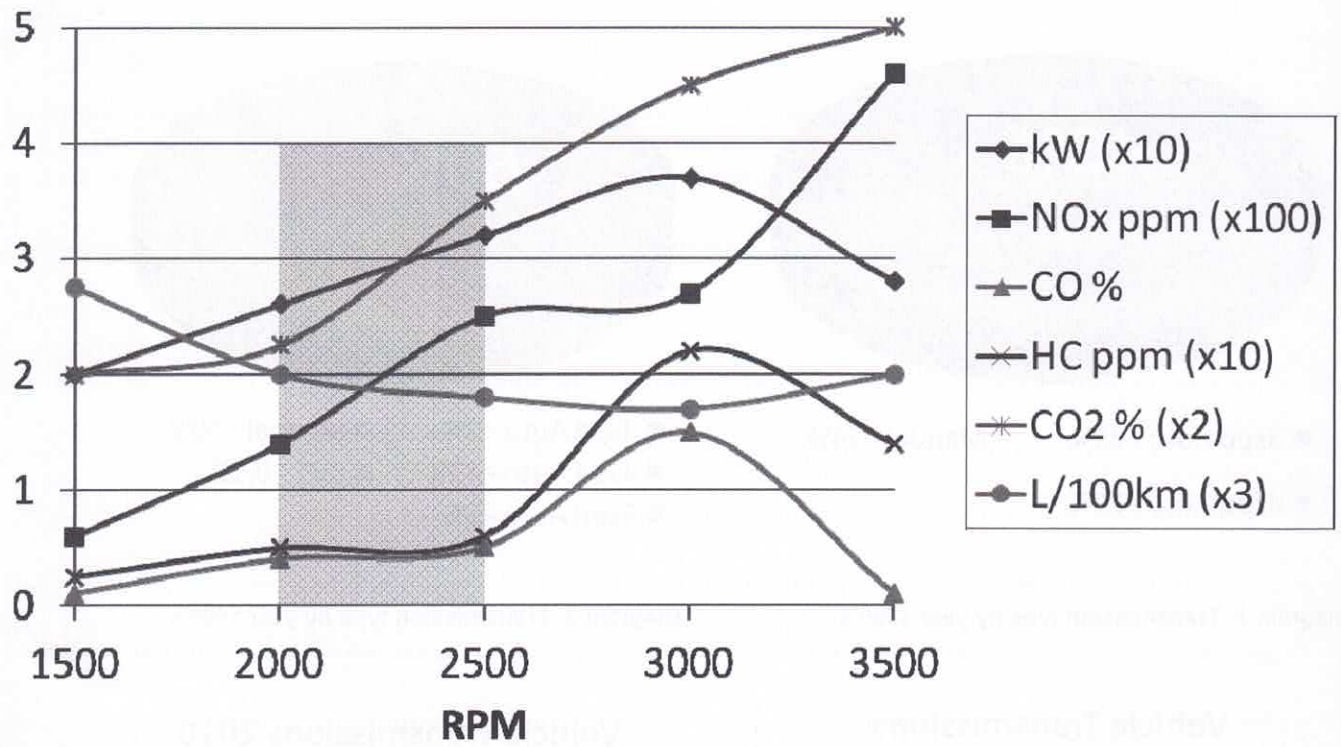

Diagram 5: Vehicle emissions vs. fuel consumption

To harness this efficiency, a transmission is needed that can keep the engine within the 'sweet spot' as often as possible. This unfortunately is not as straight forward to achieve and that is because in order to create a variation in drive ratio we need to use some of the engines energy.

INTRODUCTION continued...

The figures shown indicate the average losses between the input and output shafts of each transmission type.

Manual Transmissions

1:1 gear ratio delivers 98% efficiency, all other gears are reduced to 96% with the drive transfer through the counter shaft, this is usually averaged to 97%.

Pros
Great in-out unit efficiency, lowest manufacturing cost, low service cost and a long service life.

Cons
Large torque interruption during gear shifts

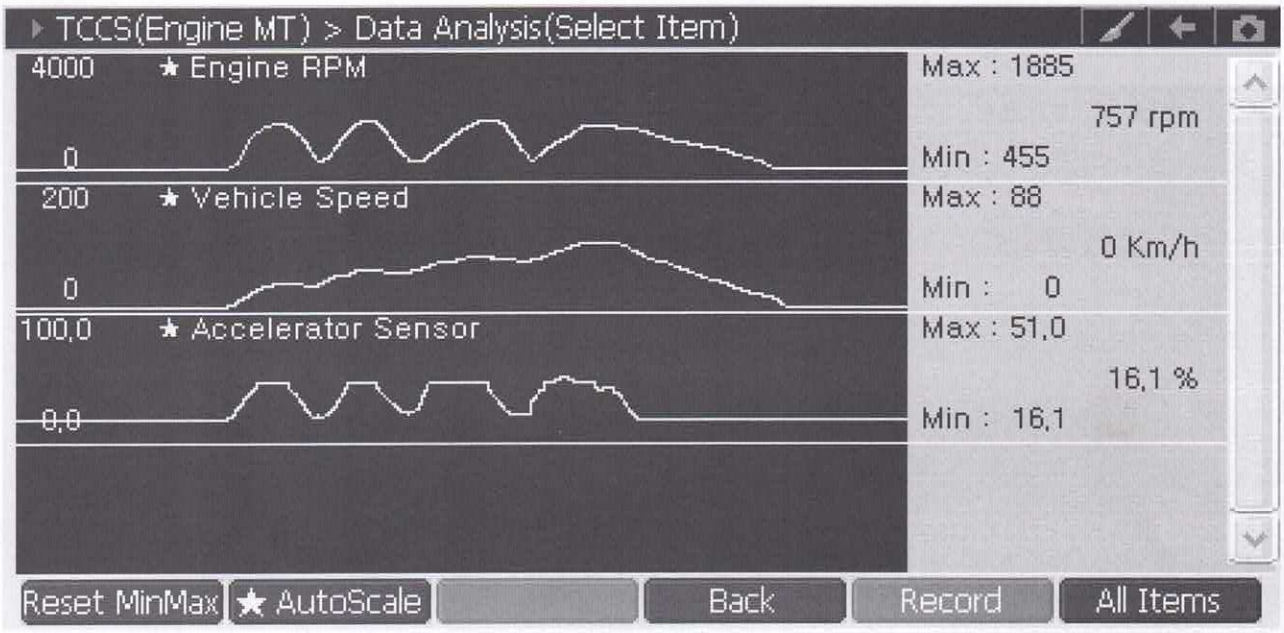

Diagram 6: Engine Speed vs. Vehicle Speed - Manual transmission

INTRODUCTION continued...

Automatic Transmissions

While the lock up torque converter helps its overall efficiency, the automatic transmission still achieves only achieves around 86% efficiency. Most efficiency is lost at the torque converter with the secondary loss being the energy required to actuate the hydraulic components. Because the Auto Trans loses most of its efficiency at the torque converter and through oil pumping the physical efficiency is unchanged regardless of the number of gears.

Pros

Relatively low manufacturing cost (although price escalates with the number of gears), low service costs and a long service life. Another benefit is achieving good to very good engine emissions particularly with the 8 and 9 gear options.

Cons

Poor in-out unit efficiency

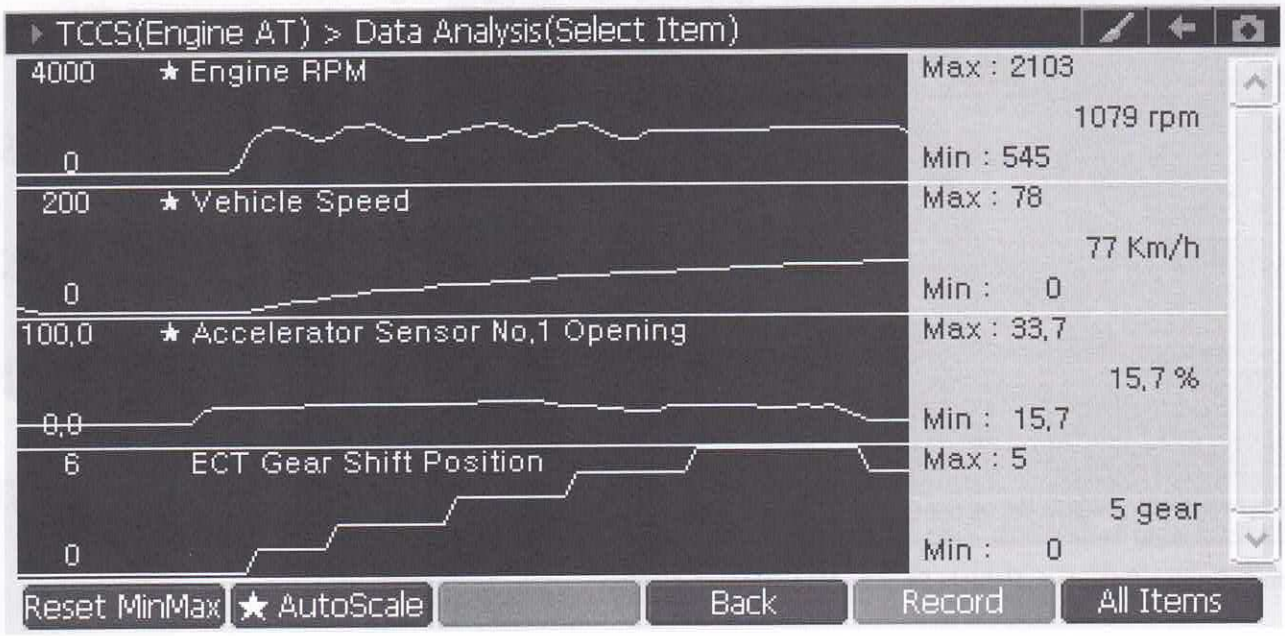

Diagram 7: Engine Speed vs. Vehicle Speed - Automatic transmission

INTRODUCTION continued...

Constant Velocity Transmissions (CVT's)

The CVT's low efficiency of 88% is due mainly to the pumping losses needed to control the variable drive units (variators). This poor internal efficiency counteracts its second to none ability of to be able hold the engine exactly at it desired rev range (whether that be the efficiency range or the power range) and accelerate through the increasing output ratio.

Pros

Second to none for engine efficiency

Cons

Large pumping losses increased manufacturing cost, higher service costs and increasing evidence of a reduced service life.

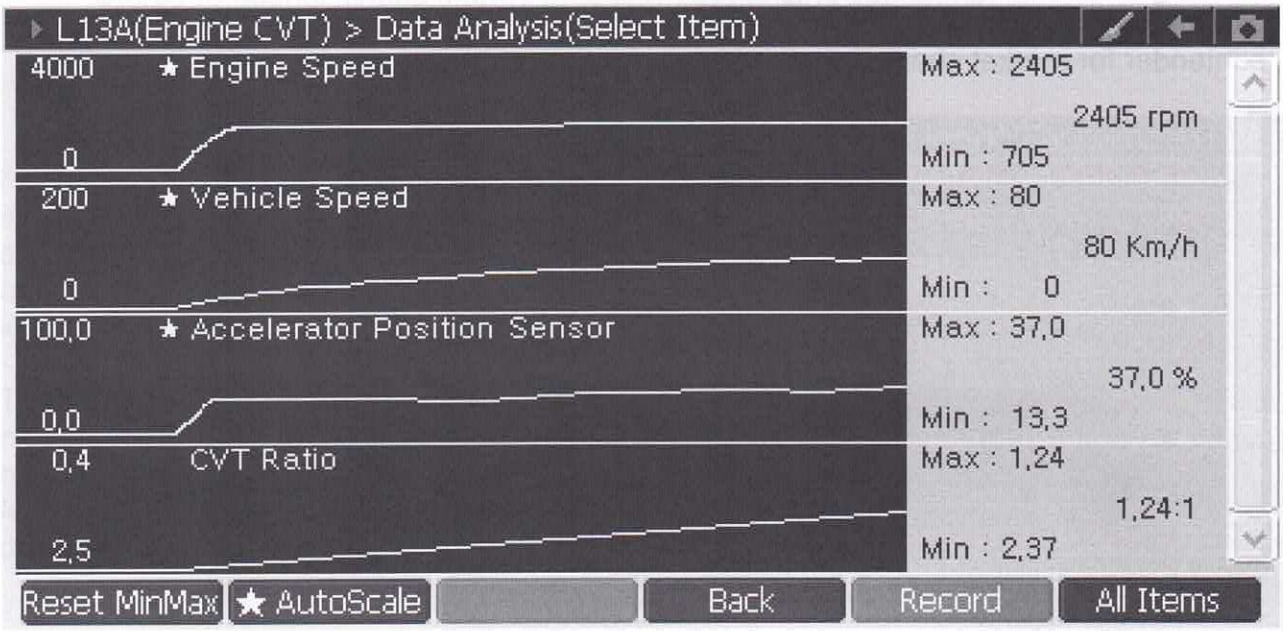

Diagram 8: Engine Speed vs. Vehicle Speed - CVT

INTRODUCTION continued...

Dual Clutch Transmissions (DCT's)

The DCT is the newest innovation in the strive for ultimate fuel efficiency and driving experience. At 85% it achieves similar efficiency levels to the manual transmission with the 2% difference being attributed to pumping losses of the control system and clutch bathing.

Pros

Lightning fast gear shifts reduce torque interruption the biggest setback of the manual transmission. Highest efficiency of all automated transmissions and neutral at idle improves efficiency further.

Cons

Unfortunately like the CVT the high manufacturing and service costs and reduced service life are preventing the DCT from dominating the transmission market.
That said future advancements may address some or all of these setbacks and see the DCT as a real contender for market share.

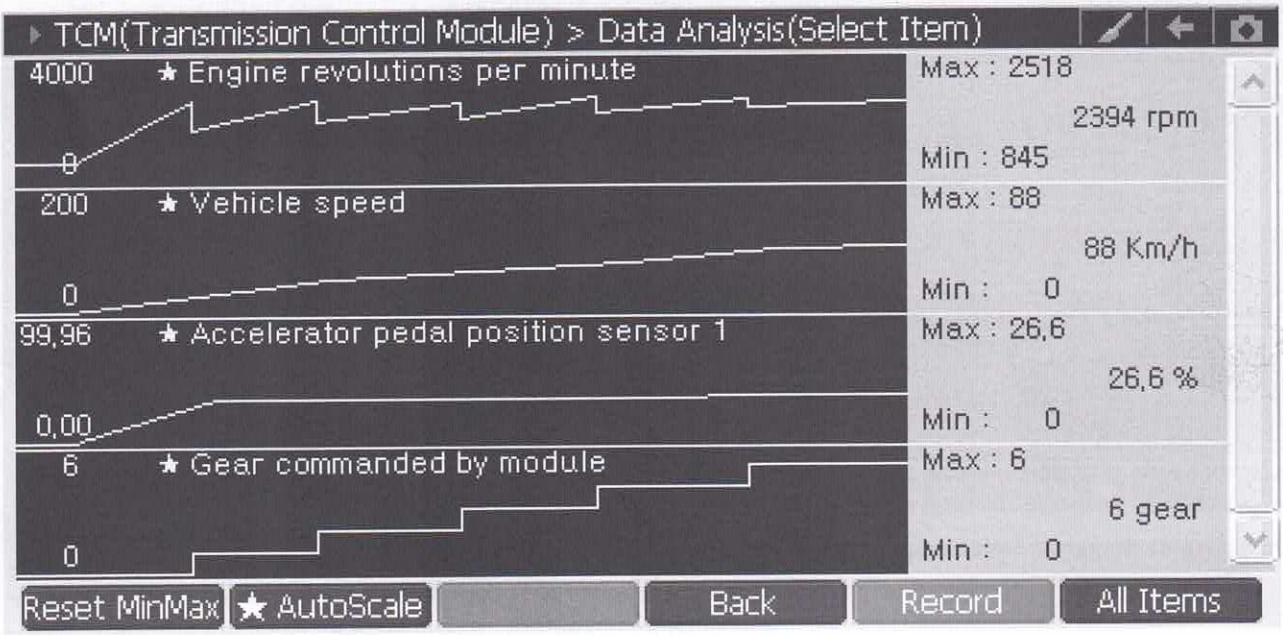

Diagram 9: Engine Speed vs. Vehicle Speed - DCT

The Basics

The following section is a quick introduction into the basic components of an Automatic Transmission. This is not an exhaustive list but rather a broad coverage of the major components and its purpose is to outline the design for those who are yet to see the inner workings of an Automatic Transmission or to refresh the minds of those who have not seen one in a long time.

Torque Converter

The torque converter is connected to the engines crankshaft via the flex plate and provides numerous functions:

- As a clutch to allow the engine to idle while the transmission is in gear
- As a torque multiplier to assist in launching the vehicle from stationary
- Stores rotational kinetic energy to smooth out engine variations
- Absorb torsional vibrations
- Houses the lock up clutch
- Drives the transmission oil pump

For transverse orientation the torque converter is usually squashed from a round chamber to an elliptical chamber to reduce its size. This affects it efficiency, a good analogy is to compare the easy of creating a whirlpool in a round drum versus creating a whirlpool in an oval shaped bathtub. Other than this, the transverse torque converter carries out the same function as its longitudinal ancestor.

The latest variation to the torque converter involves how it is controlled. Modern control systems no longer 'Lock-up' the clutch. Instead, the use of pulse width modulated (PWM) control see the clutch applied in varying degrees but never achieving complete lock up. This is a driveability feature that allows less of the engines vibrations to transfer through to the transmission. The downside is increased heat and stress of the automatic transmission fluid (ATF).

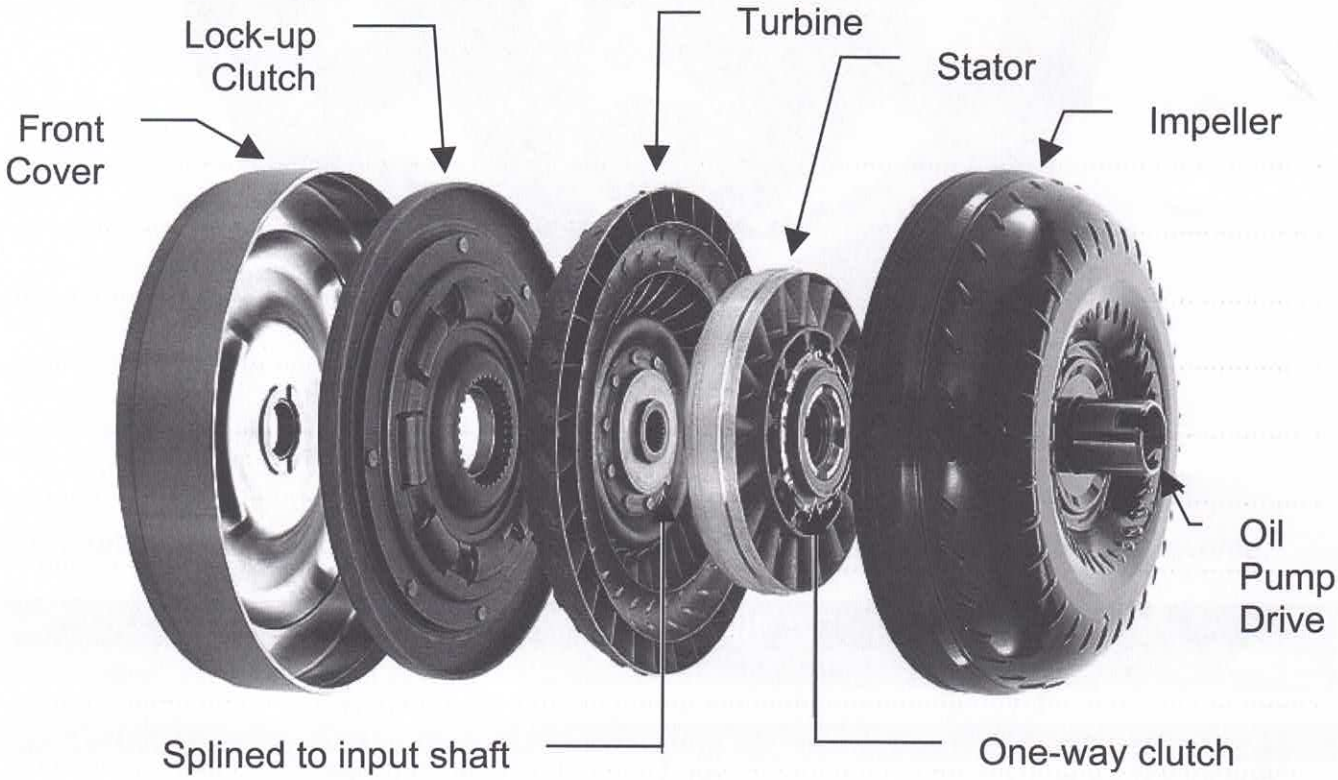

Diagram 10: Torque Converter – exploded view

THE BASICS continued...

Oil Pump

The transmission oil (fluid) pump is driven off lugs on the rear of the torque converter housing, this means that the pump is driven whenever the engine is running. It has a very important role of supplying the transmission with its high demand for pressurised automatic transmission fluid (ATF).

The most common type of oil pump is the crescent pump. Duocentric gear pumps are also used and many of the newest generation of transmissions (particularly in transverse installations) are moving toward the use of chain driven vane pumps as a space saving measure.

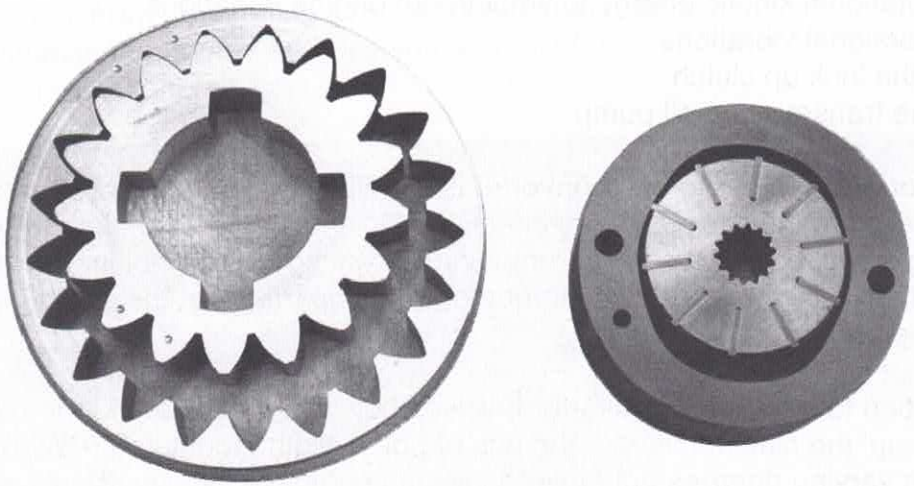

Diagram 11: Oil Pumps – Crescent type (left) and Vane type (right)

THE BASICS continued...

Compound Gearsets

Epicyclical (planetary) Gearset

The Epicyclical Gearset is the key principle to all automatic transmission. It is based on a system where all gears are constantly in mesh and variations in output speed and direction are controlled by altering the input element, the holding element and the output element. Another principle of a planetary gearset is that if any two elements are locked together the entire gearset lock the input and output providing 1:1 ratio.

The planetary gearset comprised of a Sun Gear, a Ring Gear (or Annulus) and the Planet Gears which are tied together by the Planet Carrier (not shown).

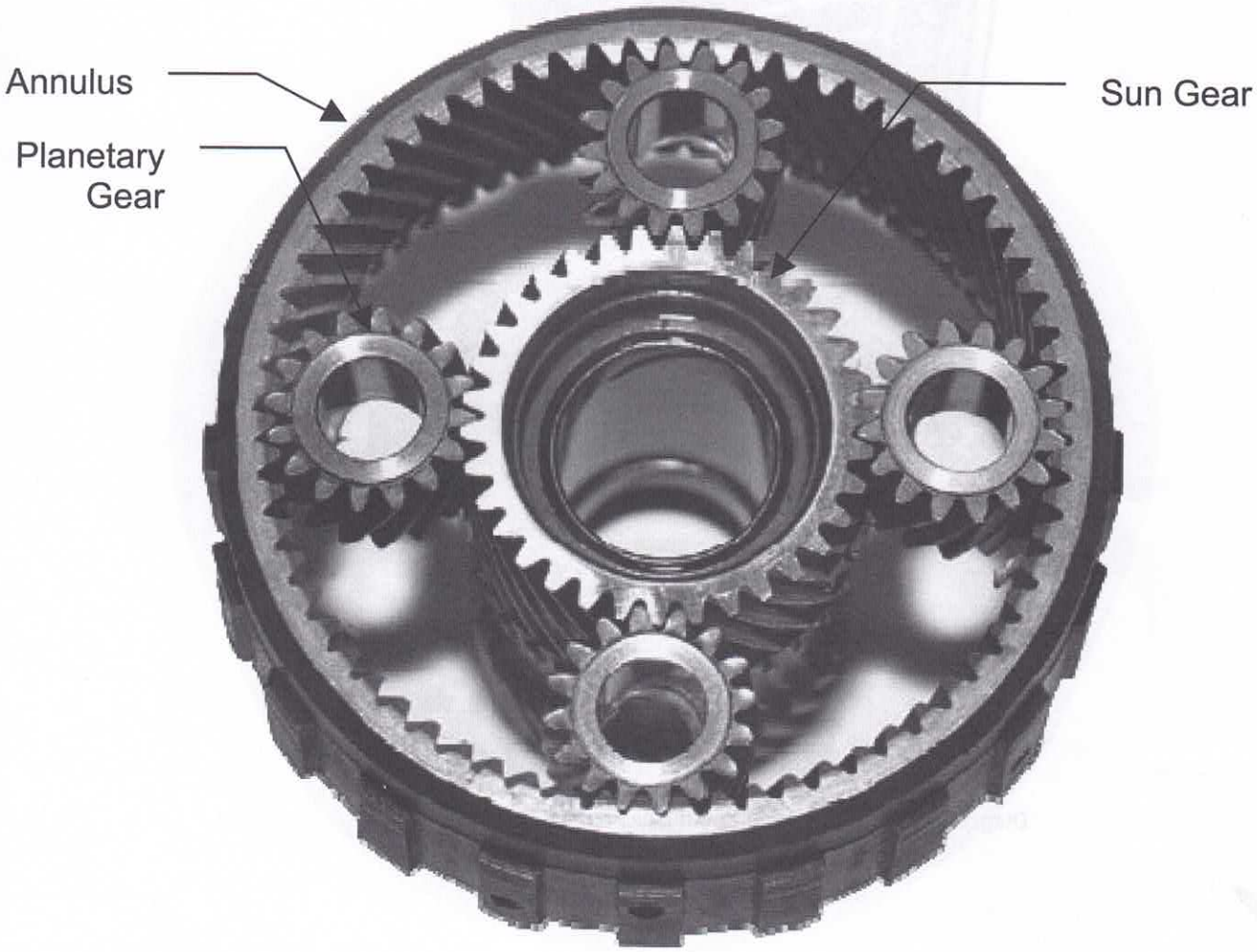

Diagram 12: Epicyclical Gearset

Table 1 sets out how a single planetary gearset can provide three forward gear plus reverse.

Input	Lock	Output	Result
Sun	Ring	Planet Carrier	Reduction
	Any two		1:1
Planet Carrier	Sun	Ring	Overdrive
Sun	Planet Carrier	Ring	Reverse Reduction

Table 1: Ratios of a basic Epicyclical Gearset

THE BASICS continued...

Simpson Gearset

The Simpson Gearset merges two planetary gearsets (usually of equal ratios). To reduce the number of elements the sun gear is shared.
This arrangement typically uses seven elements (up to four at a time) to achieve three forward gears with one reverse and is found in the majority of three speed transmissions.

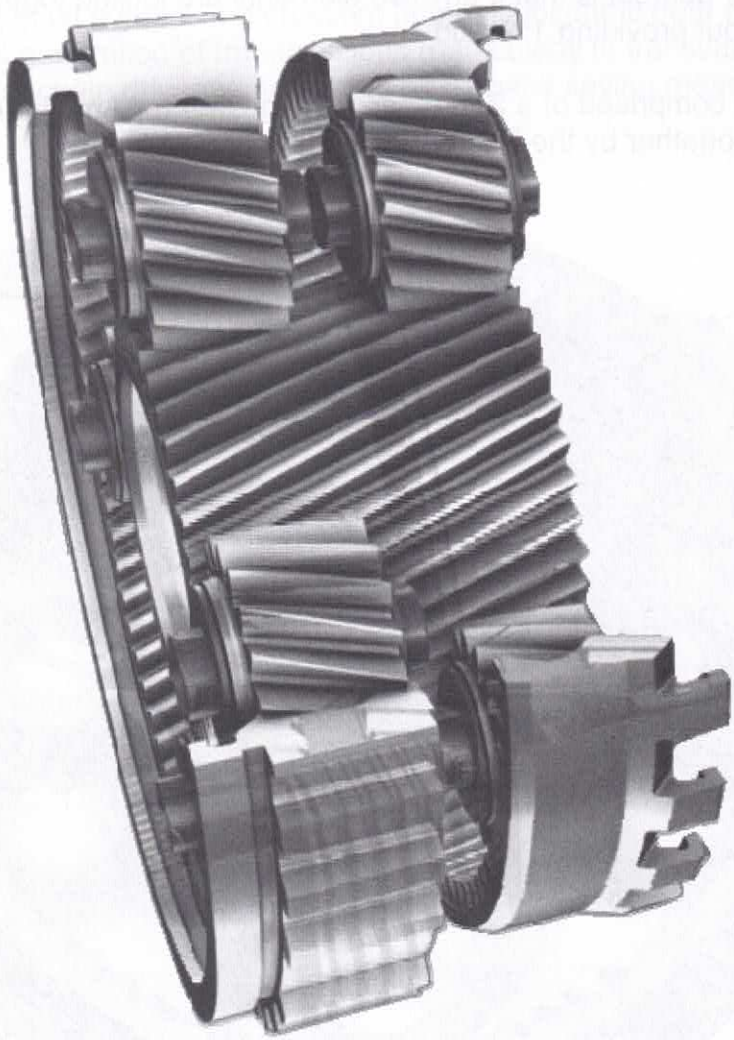

Diagram 13: Simpson Gearset (image source: ZF)

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THE BASICS continued...

Ravigneaux Gearset

The Ravigneaux gearset was first found in Australia in the Ford FMX transmission, however is found in most four speed transmissions.

The Ravigneaux design consists of two gearsets like the Simpson, but in a much more sophisticated configuration. The following list sets out the principles:

- Two unequal ratio planetary gearsets
- Linked by a shared planet carrier
- A single ring gear
- Ring gear always the output

Diagram 14: Ravigneaux Gearset

Table 2 sets out the orientation of a typical Ravigneaux 4 speed transmission power flow.

Gear	Input	Brake	Output
First	Sun 1	Planet Carrier	Ring Gear
Second	Sun 1	Sun 2	Ring Gear
Third	Sun 1 and 2	N/A	Ring Gear
Fourth	Planet Carrier	Sun 2	Ring Gear
Reverse	Sun	Planet Carrier	Ring Gear

Table 2: Ratios of a Ravigneaux Gearset

THE BASICS continued...

Lepelletier Gearset

The Lepelletier design utilises a single planetary in underdrive in front of a Ravigneaux gearset. The Lepelletier gearset has become hugely popular (used in almost all light vehicle 6spd autos) because of the simplicity of its shift elements.

The Lepelletier design can achieve 6 forward gears and a reverse with only 5 shift elements (two more gears than a Ravigneaux on its own and the same number of shift elements). Another advantage of the Lepelletier is that only 2 elements are in use at any one time and all gears shifts only require a single element shift. This makes it easier to achieve smoother gear shifts.

THE BASICS continued...

Nested Gearsets

Nested (or stacked) gearsets use the same principles as all planetary gearset with the additional feature of the annulus of the inner gearset doubling as the sun gear for the outer. This design has been adopted in the latest generation nine speed transmissions.

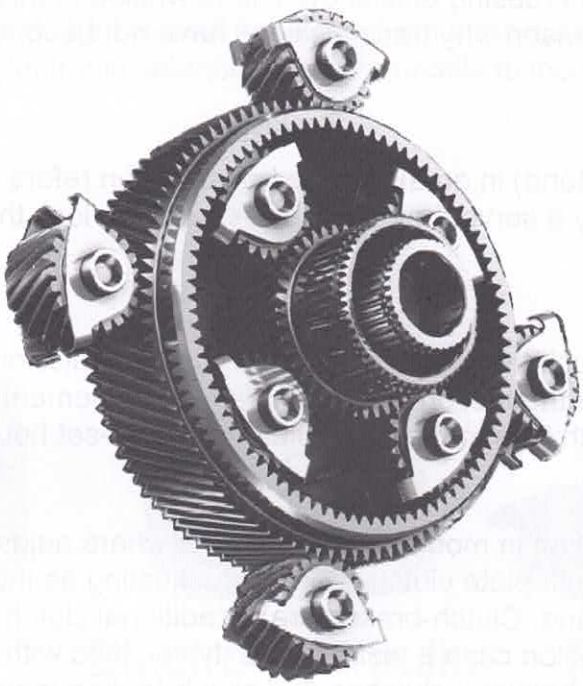

Diagram 15: Nested Gearset (image source: ZF)

Nested gearsets reduce the transmission length but significantly impact the transmission girth, making them more suitable for transverse transmissions.

THE BASICS continued...

Application Elements

Each gear in the set as well as the Torque Converter Clutch relies on hydraulic fluid pressure to engage/disengage each element. This operational principle has remained unchanged since the modern automatics birth in the 1930's.

Advancements in transmission design have proven that the greater the number of frictional elements used, the lower the in-out unit efficiency. So, more gearsets with fewer shift elements (by splining certain sun gears to the input shaft) minimises the control system and improves shift characteristics. As well as increasing efficiency. The downside of this design is size and weight are increased. This is the reason why transmissions have not become more compact.

Brakes

The term Brake (or Brake Band) in an automatic transmission refers to a band that is wrapped around a drum. Actuated by a servo they are typically used to lock the ring-gear of a planetary gear-set to the housing.

Clutches

Clutches are also used to lock the movement of specific transmission elements. The multi plate clutch packs typically spline the friction plates to the moving element while the interspersed metal plates are located with lugs to the outer planetary gear-set housing.

Clutch-brakes

Clutch-brakes are an evolution in modern transmissions where adjustments are no longer required, this is because multi-plate clutches are self adjusting as they wear and have a longer service life than a Brake Band. Clutch-brakes are a traditional clutch pack but are used to lock the element to the transmission case a task previously serviced with a Brake Band. While some manufacturers differentiate between clutches and clutch-brakes many refer to them simply as clutches or brakes.

One-way clutches

One-way clutches are used whenever a transmission element only needs to be locked from turning in a certain direction. One-way clutches are completely mechanical devices and require no direct control. There are two main types of one-way clutches:

- Sprag
- Roller

While they are more energy efficient than clutches, their exact engagement point is difficult for a control module to anticipate leading to harsher shifts. Many later model transmissions are moving away from the use of these and are referred to as 'Clutch to Clutch' transmissions

THE BASICS continued...

Control

Unlike the application elements the transmission control system has evolved somewhat. While the hydraulic valve body has remained through this evolutionary process its size and function has adapted.

The design of any valve body is a complex network of galleries and valves. Valves not only control the servos that apply the frictional elements but also other valves that control system pressure. The complexity of many of the hydraulic circuit diagrams is mind boggling.

The evolution of the valve body had seen it transform from a mechanical inputs such as throttle linkages and governors to electronic solenoids and eventually to incorporating the Transmission Control Module (TCM).

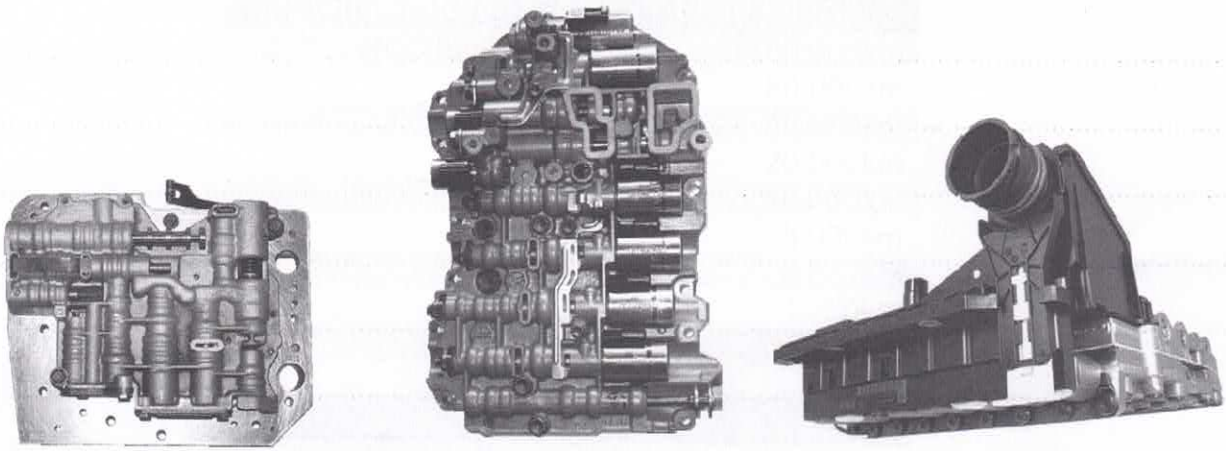

Diagram 16: The evolution of valve bodies

Automatic Transmission Fluid (ATF)

The following quote summarises the importance of the ATF.

"Automatic transmission[s] operate on fluid pressure.
Fluid actually drives the vehicle
by coupling the engine to the transmission inside of the torque converter.
Fluid applies the clutches, cools the transmission and lubricates the geartrain."

Source: Audi of America

The mineral base stock of most fluids have an optimal operating temperature is 79°C, higher operating temperatures increase oxidation reducing the service life of the fluid by one half life per 11°C increase (see *Table 3*). 160,000km's is the service life of this fluid base stock when operating at its optimal operating temperature of 79°C.

Temperature	Fluid Life
79°C (optimal)	160,000km
90°C	80,000km
101°C	40,000km
112°C	20,000km
123°C	10,000km
134°C	5,000km
145°C	2,500km
156°C	1,250km
167°C	625km
178°C	313km
189°C	156km

Table 3: ATF life vs. Temperature

ATF ANALYSIS

There are so many statements made by manufacturers that transmissions don't need to be serviced and dealers stating that: *"If your mechanic changes your transmission fluid they are ripping you off!"* Of course the OE Dealers have the vehicle manufacturers and the component manufacturers and all of their engineers, lawyers and marketing experts to support/sell their claims.
Meanwhile, there are just as many industry experts with a wealth of hands on experience about what is happening to these components that state: If you want your transmission to last you need to service regularly.

We at Auto-Tech didn't want to just add another voice to the argument. Instead, we chose to test the fluid and let the lab results speak for themselves.

To do this we had to chose a modern and popular transmission so the ZF 6HP immediately came to mind. Not only because of its popularity but also because the patented ZF Lifeguardfluid6 is claimed to be one of the most advanced fluids available.
If we can disprove Lifeguardfluid's ability to last "a lifetime" then the inferior fluids must follow suit!

Oil Samples

We received six suitable oil samples from a variety of sources. The results from the oil analysis are provided in *Table 4*.

ATF ANALYSIS continued...

Sample	Baseline	1	2	3	4	5
Make	ZF	Ford	Range Rover	Land Rover	Range Rover	Ford
Model	Lifeguardfluid6	FG Falcon	V8 Petrol	Discovery 3 TDV6	Sport TDV8	Territory
Fluid age	New	4 months	5 years	7 years	5 years	6 years
Fluid km's	0	9,100	64,600	71,100	143,000	190,000
			Oil Condition			
Viscosity 40°C (cSt)	25	25	25	25	25	26
Viscosity 100°C (cSt)	5.4	5.6	5.4	5.7	5.5	5.5
Water (%)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
TAN (mg/KOH/g)	1.79	1.70	3.11	2.29	2.62	3.33
			Cleanliness			
ISO- 4406 index	15/14/11	16/15/12	19/18/15	16/15/13	18/17/15	>25/22
≥ 2 µm (ppm)	217	423	2602	576	1859	>320000
≥ 5 µm (ppm)	118	230	1417	314	1012	>320000
≥ 15 µm (ppm)	20	39	241	53	172	20-40000
Rating	Low	Low	Elevated	Moderate	Elevated	Very High
			Elements			
Iron (Fe)	2	35	213	272	229	200
Lead (Pb)	<1	1	2	31	2	108
Copper (Cu)	1	65	611	380	454	567
Chromium (Cr)	<1	<1	<1	<1	<1	<1
Tin (Sn)	<1	3	58	30	42	51
Aluminium (Al)	<1	22	133	74	83	115
Manganese (Mn)	<1	1	3	17	15	3
Silicon (Si)	2	4	11	10	12	20
Sodium (Na)	5	10	18	18	18	22
Calcium (Ca)	518	509	537	544	533	539
Zinc (Zn)	2	4	23	14	21	15
Phosphorus (P)	371	370	429	412	415	421
Magnesium (Mg)	1	2	3	3	3	2
Barium (Ba)	1	1	1	1	1	1

Table 4: ATF sample analysis

ATF ANALYSIS continued...

Understanding the oil analysis

Condition

Viscosity
The viscosity of ATF is standardised at three temperatures (-40°C, 40°C & 100°C). Contaminants in the oil may affect its viscosity leading to increased wear. The parameters for viscosity variation are set by the component or lubricant manufacturer. In the absence of these values a variation above 10% is considered unacceptable for automatic transmissions.

Water
Water is measure in percentage. This is done by means of a crackle test (heating the ATF until the water boils out and the crackling stops. Then weighing the difference of the sample)

TAN
The Total Acid Number (TAN) of a fluid is a means of measuring the acid content of the fluid and is particularly important in ATF. All ATF's have a TAN, it is important to monitor this value as overheating and over use contribute to oxidisation of the ATF causing the acid levels to increase.

Excessive levels of acid cause corrosion that can weaken the hardening of steel components such as shafts and gears as well as the metal structure of heat exchangers and oil cooler. The TAN limits may be set by the component or lubricant manufacturer but in the absence of these values a variation above 10% is considered unacceptable for automatic transmissions.

ATF ANALYSIS continued...

ISO Cleanliness

The cleanliness of oil is standardised by ISO-4406 and is used to quantify the amount of contamination in oil or fluid.
The contamination must be measured at 3 sizes on the scale of micrometers (eg. 2µm/5µm/15µm) and the code is expressed as 3 numbers each separated by a forward slash (eg. 16/15/13). Each particle size measures all particles of that size and larger, so the number will always be descending as per the example)

Range Code	Part per million (ppm)
9	2.5 – 5
10	5 – 10
11	10 – 20
12	20 – 40
13	40 – 80
14	80 – 160
15	160 – 320
16	320 – 640
17	640 – 1300
18	1300 – 2500
19	2500 – 5000
20	5000 – 10000
21	10000 – 20000
22	20000 – 40000
23	40000 – 80000
24	80000 – 160000
25	160000 – 320000
26	320000 – 640000

Table 5: ISO-4406 Cleanliness Chart

ATF ANALYSIS continued...

Elements

Elements are made up of a combination of Oil Additives, Wear Metals and Contaminants. Sometimes it is possible for an element to be in more than one of these categories.

Element (ppm)	
Wear Metals	
Iron (Fe)	Gears, bearings, shafts, some cases, clutch plates, brake bands
Lead (Pb)	Residual gear marking compound, alloy of bronze, clutch plates
Copper (Cu)	Bronze bushings, oil cooler oxides, clutch plates, brass fittings
Chromium (Cr)	Ball and roller bearings, alloy of steel parts like gears and shafts
Tin (Sn)	Some bearing cages, alloy of bronze, clutch plates
Aluminium (Al)	Torque converter, the case, pumps, thrust washers
Manganese (Mn)	Alloy of steel
Contaminants	
Silicon (Si)	Airborne dirt, sealers, gaskets, sand-casted parts, and spray lubricants, antifreeze
Sodium (Na)	Antifreeze
Oil Additives	
Calcium (Ca)	Detergent / dispersant additive
Zinc (Zn)	Anti-wear additive
Phosphorus (P)	Anti-wear additive
Magnesium (Mg)	Detergent / dispersant additive
Barium (Ba)	Detergent / dispersant additive (usually only in synthetic oil)

Table 6: ATF elements

ATF ANALYSIS continued...

ATF Analysis Summary

All samples from 64600km or 5 years showed:

- Moderate to High TAN
- Moderate to Very High Particulates
- Excessive wear elements attributable to:
  - Gearsets
  - Shafts
  - Bearings
  - Clutch Plates
  - Thrust Washers
  - Brass/Bronze Bushings
  - Oil Pump Housing
  - Torque Converter
  - Case

Based on these findings it would be advisable to renew the ATF in all of the vehicles sampled every 60,000km's. However, this is based on 100% of the fluid be changed out, as a normal transmission service only renews approximately 40-50% the intervals of the type of servicing should be between 24,000 to 30,000km.
The results from the oil analysis do not suggest that time plays a huge factor in oil quality.

ATF TYPE

When it comes to choosing the correct fluid to use in any automatic transmission, the options are numerous but the choice is straight forward.
Broad sweeping statements on multi-use ATF's like: *"recommended for long drain use in 4, 5, 6 and 8 speed automatic transmissions used in Asian, European, American and Australian cars"* make finding its actual suitability difficult.

As discussed during the ATF Analysis, the variation in viscosity should be within 10% of the factory fill. This means that the 100°C Viscosity must be within 0.4 to 0.6 cSt of the recommended viscosity and remain within that parameter for their period of use. This factor alone makes multi-use ATF's unsuitable for the majority of modern transmissions. Other factors that also need to be met are:

- Appropriate base stock
- All Viscosity points (-40°c, 40°C & 100°C)
- Water content
- Total Acid Number (TAN)
- Cleanliness
- Additives

All of these factors distil down to the only suitable fluid for a transmission is the recommended Factory Fill ATF or a licensed equivalent. Licensed equivalents are fluids that carry the name of the Factory Fill ATF as the ATF name on the front label but are blended under licence by an alternative company and will also carry an approved licence number somewhere on the label. The most popular licensed ATF's include many of the blends in the MERCON® and DEXRON® range.

If you are unsure if a fluid is suitable most vehicle manufactures publish a list licensed options on their website (hint: search by factory fill fluid name) and if you're still unsure don't risk it. Using the incorrect fluid can result in poor driveability, harsh shifts, torque converter clutch shudder, slippage, increased operating temperatures and ultimately a reduced service life of the transmission unit.

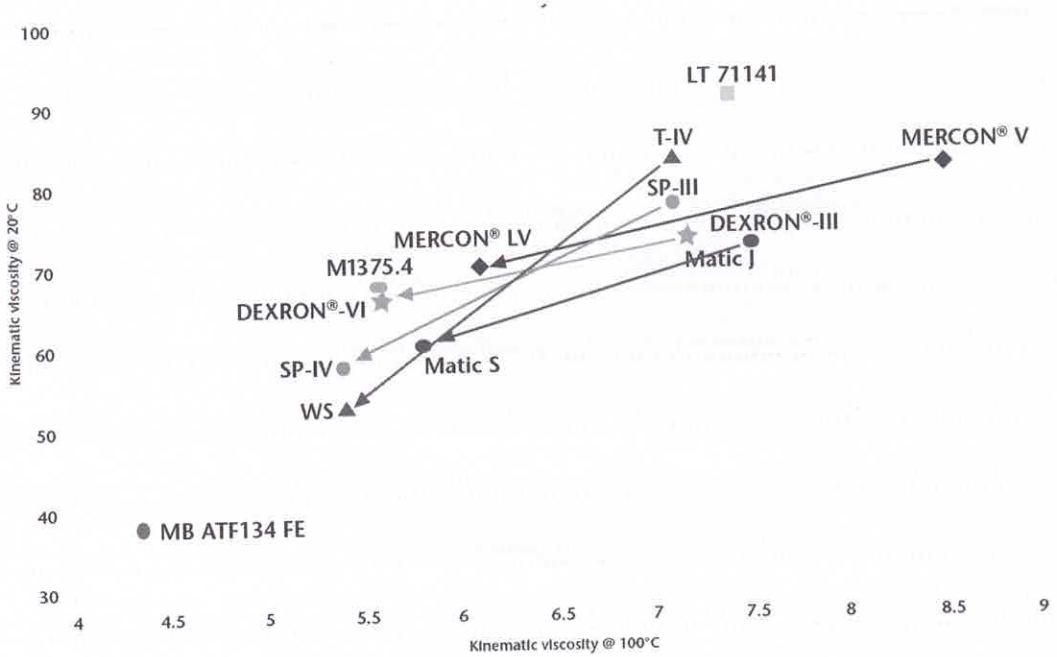

Diagram 17: Commercial factory fill ATF viscometrics (image source: Infineum Int. Ltd.)

SERVICING INTERVALS

The catch phrase for the majority of modern automatic transmission service scheduling is *"Filled for Life"* or *"Sealed for Life"*. However what manufacturers do not state is what they perceive the *"Life"* of a transmission to be. Could they mean?

- The life of the vehicles warranty,
  of course the amount of vehicle warranty varies considerably between manufacturers, models and promotions. 3yr/100,000kms appears to be somewhere about the average.
- ADR states the life of a vehicle to be the period it must meet its emission standard,
  ADR 79/01 (Euro III) states that a vehicle must meet its emission requirements for 5 yrs / 80,000km,s and ADR 79/02 (Euro IV) states that a vehicle must meet its emission requirements for 5 yrs / 100,000km,s
- Design life,
  Although it is very rarely stated officially, there is growing evidence that the majority of manufacturers are designing their vehicles to last 10 years/240,000km's.
- Lifetime of use,
  According to the Australian Bureau of Statistics (ABS) in September 2012 the average age of a car is 10.0 years. The breakdown is as follows:
  - There are 16.7 million registered cars
  - 3.2 million are 0-3 years old (meaning they are most likely to be serviced by the dealer)
  - 6.8 million are 4-10 years old
  - 6.7 million are older than 10 years (making the average retirement age of a car around 17 years)

Table 7 shows the standard and severe service intervals for the most popular selling cars of the last 3 years.

Make	Model	Normal Service (km/yrs)	Severe Service (km/yrs)
Mazda	3	Sealed	Not Required
Toyota	Hilux	Sealed	80,000/4
Toyota	Corolla	Sealed	80,000/4
Holden	Commodore	150,000/7.5	75,000/3.75
Holden	Cruze	150,000/7.5	75,000/3.75
Hyundai	i30	Sealed	Not Required
Toyota	Camry	Sealed	90,000/4.5
Nissan	Navara	Sealed	40,000/2
Toyota	Yaris	Sealed	80,000/4

Table 7: Transmission service intervals for the most popular vehicles 2010-2013 (source: ABS)

Servicing an automatic transmission correctly can only increase its service life. Add to this the findings in the ATF Analysis and the optimal service life appears to be in the range of 24,000 to 30,000km.

SERVICING PROCEDURE

A transmission service requires more than simply draining and topping up the ATF. Although service adjustments are now a thing of the past a transmission service should still include:

- Road test
- Fault code check
- Filter change
- Oil change

Road test

The road test is an essential starting point. It can identify driveability issues. But more importantly, if a driveability issue arises after the service the technician will know if it was present prior to the service.

Fault code check

There is little point in servicing a faulty transmission unless the fault may be the result of worn fluid.
Secondly, most transmission faults require the draining of the fluid and removal of the pan for diagnosis and repair in which case the new fluid is lost.

Filter change

For most transmissions this is relatively straight forward.

Oil change

The oil change while relatively straight forward does present the technician, workshop and customer with a number of options (see *Table 8*)

Method	Fluid Changed	Fluid Required	Filter Replaced	Clean Magnet/s and Pan
Drain	30-40%	30-40%	No	No
Remove Pan	40-50%	40-50%	Yes	Yes
Remove Pan + Addition Drain	60-75%	80-100%	Yes	Yes
Extract	95%	Up to 200%	No	No
Remove Pan + Extract	97%	Up to 225%	Yes	Yes
				Note: % of fluid is based on Dry Fill quantity

Table 8: Fluid drain quantities by method

SERVICING PRECAUTIONS

Aftermarket service kits

Unlike some ATF's, filters, gaskets and other servicing items can be reproduced to match or even better the quality and performance of original equipment (OE) parts. Ensure that the supplier states that their replacement parts match or exceed OE specifications.

Lip Seal Installation

The installation of lip seals to transmission filters is a critical procedure. The filter of most modern transmissions doubles as the ATF pick-up pipe. If the seal is not fitted correctly it can allow air to be drawn into the oil pump.

There are two types of Lip Seals

- Multi-lip rubber seals
- Hard cased lip seals

Multi-lip rubber seals

1. Remove old filter
2. Ensure old seal is removed from the transmission
3. **Fit new seal to the filter spout**
4. Lubricate the seal well with trans fluid
5. Install the filter together with the new seal

Hard cased lip seals

1. Remove old filter
2. Remove the old seal from the transmission
3. **Install new seal into the transmission** with a special service tool (SST)
4. Lubricate the seal well with trans fluid
5. Install the filter into the new seal

Caution: In both instances, incorrect installation can cause air leakage into the pump resulting in harsh shifts and ultimately transmission failure!

Fluid level

The "one-method-suits-most" approach of checking the fluid level was retired along with the Holden Trimatic. But before we address the most popular methods for checking the fluid level let's address why following the correct procedures is so critical.

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SERVICING PRECAUTIONS continued...

Why temperature is so critical is in transmission fluid level

There are a number of factors that affect fluid level:

1. Fluid expansion – the change in size with temperature affects all fluids as well as solids (this is known as the coefficient of expansion). While these play a part in the level variation, they are not the cause of the huge variation. Actually, these factors affect other systems (engine, manual trans, transfer case and differential) and these are not as critical to temperature. In fact there is only a very small difference in the coefficient of expansion between all of these.
2. Temperature – While the running temperature of a transmission is certainly hotter than a manual transmission or a differential, it is comparable to an engine which is not as critical to temperature.
3. Fluid Capacity – This is one of the two key contributors to the fluid level increase. The coefficient of expansion is 0.00075 (0.075% increase per 1°C) so when 10L of transmission fluid has a temperature increase of 80°C (20°C>100°C) the 10L expands to fill the area of 10.6L.

$$\frac{(0.075 \times 80)}{100} \times 10$$

4. Reservoir Capacity – This is the second of the two key contributors. Unlike most other components the transmission has a relatively small reservoir (pan) in relationship to its capacity and in addition the mechatronic unit (valve body) is submerged in the middle of it.

In Summary:
While all of the above impact on the fluid level, it is the ratio of fluid capacity to reservoir capacity that has the greatest impact. If fluid is allowed rise too high, it will be churned and aerated by the gear sets, resulting in poor performance and ultimately transmission failure.

Caution: High ATF levels are every bit as critical as low ATF levels.

Q: What are the two key factors for temperature to level variation?

a. Fluid Expansion

b. Temperature

c. Fluid Capacity

d. Reservoir Capacity

A: _____

SERVICING PRECAUTIONS continued...

Level checking methods

The ATF level checking procedures are most easily covered by grouping by method:

- Dip Stick
- Special Service Tool
- Fill Plug
- Drip Tube

Dipstick method

Typically checked with the engine running in Neutral at normal operating temperature
Usually have Cold and Hot check options, only use the Cold as an initial check. Always perform level check Hot.

Note: Hot check is preferred and always follow the manufacturer's procedure!

SERVICING PRECAUTIONS continued...

Special Service Tool (SST) method

A number of Auto makers have made the dipstick a special service tool (SST) and replaced it with a plug/cover.

The procedure is typical to all dipstick methods however the repairer must supply their own dipstick.

Some manufacturers such as the Chrysler Group have a single dipstick that covers most of the product range. The special service dip stick tool has 10mm increments (see *Diagram 18*) and different transmission models are filled to different heights.

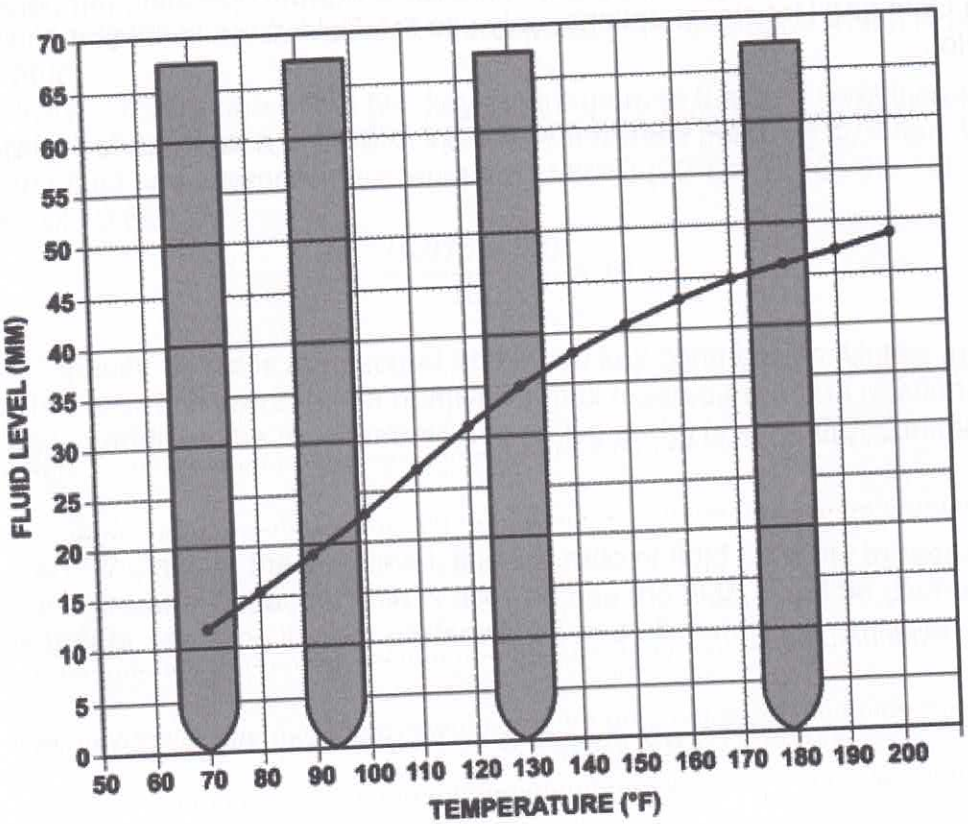


Diagram: 18: Chrysler SST level vs. Temperature chart (source: Chrysler)

Note: *Always follow the manufacturer's procedure!*

SERVICING PRECAUTIONS continued...

Fill Plug method

The fill plug method is also relatively straight forward, the only complication of using a fill plug in an automatic transmission is that temperature becomes key. This is because the plug level is static, it limits the level of fluid regardless of temperature.
While most original equipment manufacturer (OEM) procedures state the use of a scan tool is required to monitor temperature, it is perfectly acceptable to use an infrared thermometer and measure the pan temperature.

Note: Always follow the manufacturer's procedure!

SERVICING PRECAUTIONS continued...

Drip Tube method
As with the Fill Plug system, the Drip Tube level is fixed and the level check is dependent on temperature.
This method is becoming increasingly popular, due to ever increasing component sharing the Drip Tube system allows for a simple pan exchange to alter the fluid height for any specific application.

There are two methods for filling/topping-up:
1. Through the Drip Tube using a special service tool
2. Through a separate fill point located above the fluid level.

There are three methods for draining the transmission:
1. Through a separate drain plug
2. Through a removable Drip Tube
3. Via pan removal

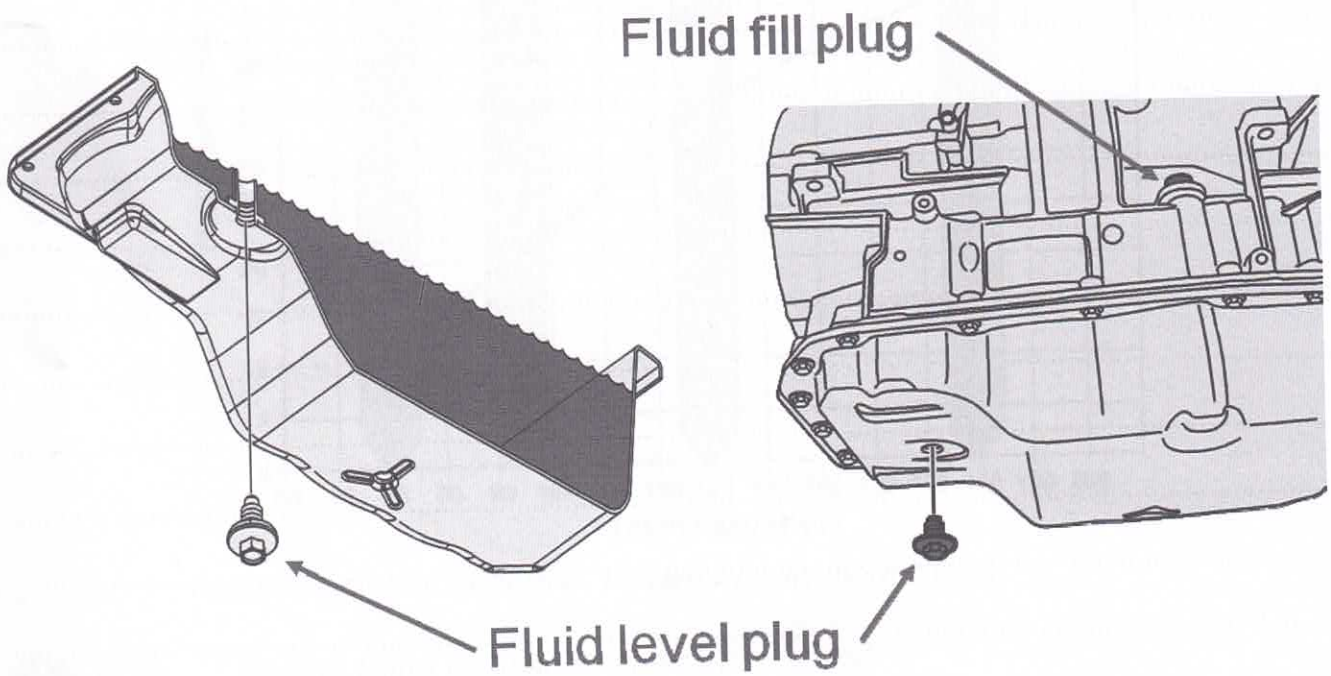


Diagram: 19: Holden 6L50 transmission level check (source: GM)

Note: *Always follow the manufacturer's procedure!*

Service Procedures

The following chapter covers the servicing procedures of the most commonly requested vehicle models.

Each model covered includes:

- ID Plate locations
- Heat Exchanger location
- Service Schedule
- Service Procedure
- Torque Specifications
- Service Kit
- Fluid Type and Quantity
- Time Guide

The vehicles covered include:

- Ford Falcon (FG) – 6 speed
- Holden Barina (TK) – 4 speed
- Holden Commodore (VE) – 5 speed
- Mazda 3 (BK) – 5 speed
- Toyota Camry (ACV40) – 5 speed
- Toyota Corolla (ZRE152) – 4 speed
- Toyota Prado (120 Series) – 5 speed

FORD FALCON (FG) – 6 SPEED

The Ford Falcon (and other FG variants) is available with a 6 speed automatic transmission that is designed and built by ZF. The transmission was introduced in 2009 and is still current.

ID Plate location

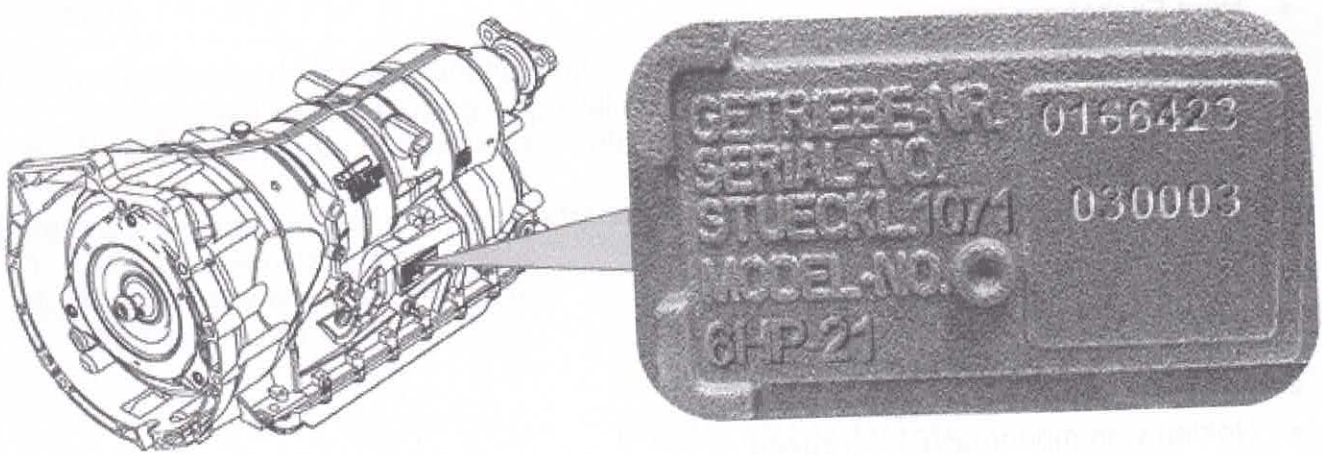


Diagram: 20: Ford Falcon (FG) – 6 speed, ID Plate location (source: ZF)

Heat Exchanger location

The transmission heat exchanger is located on the left side of the engine sump.

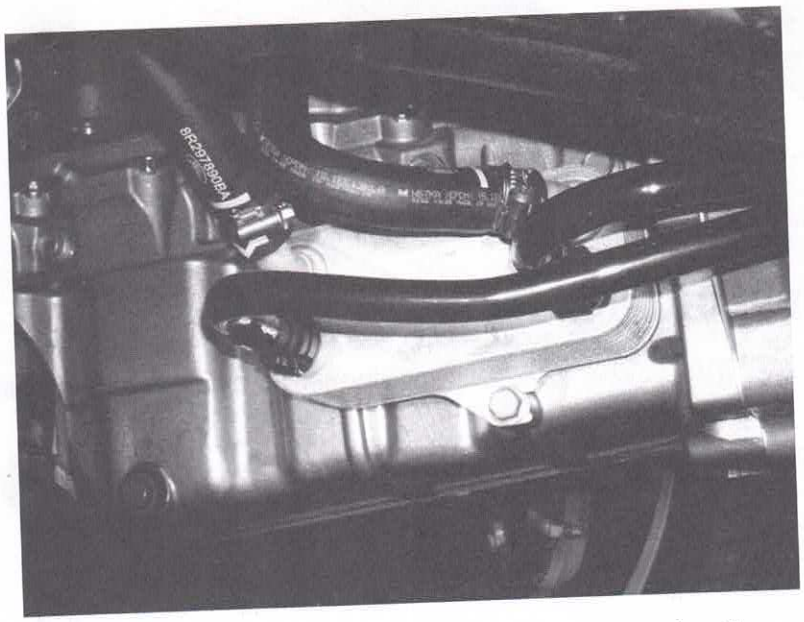


Diagram: 21: Ford Falcon (FG) – 6 speed, heat exchanger location

FORD FALCON (FG) – 6 SPEED continued...

Service Schedule

Vehicle	Inspect (km/yrs)	Normal Service (km/yrs)	Severe Service (km/yrs)
Ford Falcon (FG)	15,000km / 1yr	Not Required	Not Specified

Table 9: Ford Falcon (FG) – 6 speed, Transmission service schedule

Note: *Automatic transmission service intervals should be assessed on a case by case basis, taking into account the manufacturer's recommendations, the driving conditions, the service history as well as any other fluid condition reports available.*

Service Procedure

1. Position the vehicle on a hoist or other suitable method ensuring that the vehicle is level to allow access to the Automatic Transmission
2. Isolate the vehicle to prevent accidental starting
3. Remove the filler/level plug

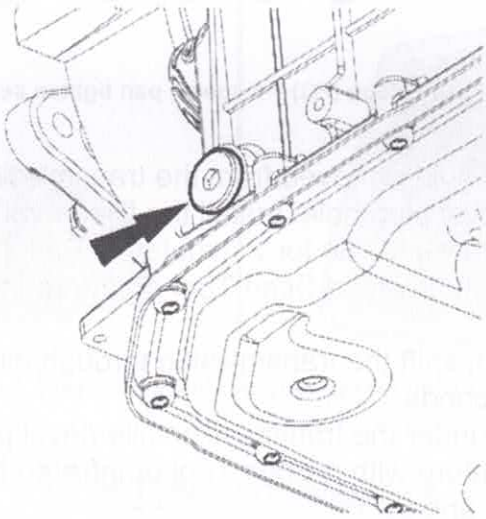


Diagram: 22: Ford Falcon (FG) – 6 speed, filler/level plug (source: Ford)

4. Place a large oil catch tray under the transmission (as close to the transmission as possible)
   4.1. For vehicles fitted with a polyamide (plastic) pan, remove the drain plug
5. Loosen the pan
6. Using a suitable prying tool, carefully release one side of the transmission pan
   6.1. For vehicles fitted with a steel pan, allow the majority of fluid to drain
7. Once drained, remove the remaining pan bolts and the pan
   7.1. For vehicles fitted with a polyamide (plastic) pan, dispose of the pan, filter and gasket
   7.2. For vehicles fitted with a steel pan, clean the gasket residue from the sealing surfaces. Wash out the pan and clean the magnets of any residue. Dispose of the old filter and gasket

FORD FALCON (FG) – 6 SPEED continued...

8. Fit a new lip seal to the filter spout and lubricate with a small amount of transmission fluid
   - 8.1. For vehicles fitted with a polyamide (plastic) pan, carefully position the new integrated pan/filter and tighten until the bolts until they are just in contact with the pan.
   - 8.2. For vehicles fitted with a steel pan, fit the filter into the valve body and then fit the pan with a new gasket and tighten the bolts until they are just in contact with the pan.
9. Tighten the pan to the specified torque in the correct sequence as shown in *Diagram 23*

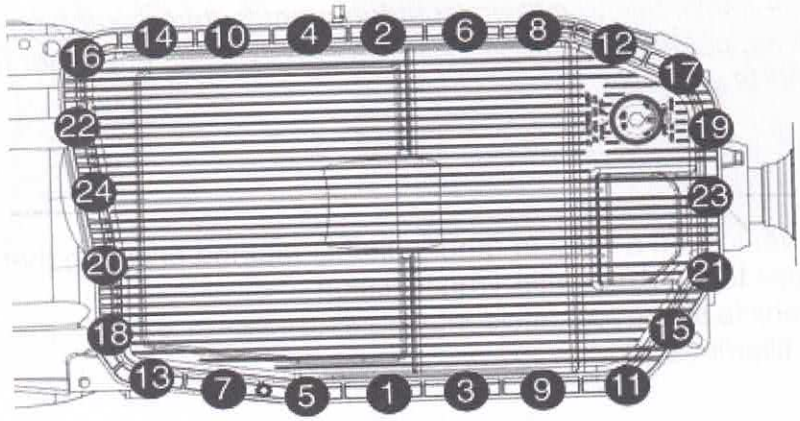


Diagram: 23: Ford Falcon (FG) – 6 speed, pan tighten sequence (source: ZF)

10. Measure the amount of fluid removed from the transmission and add this amount of new fluid through the filler/level plug hole. Install the filler/level plug loosely
11. Start the engine and allow it to idle for 2 minutes in Park position
12. Check the fluid temperature with a Scan Tool or infrared thermometer on the pan, it must be below 30°C
13. With the brakes applied, shift the transmission through all gear selections. Pausing in each selection for 3 seconds
14. Place an oil catch tray under the transmission filler/level plug and remove the plug
15. Check the fluid temperature with a Scan Tool or infrared thermometer on the pan, it must be between 30°C and 50°C

Caution: *At no point should the fluid temperature exceed 50°C. If the fluid does its threshold turn off the engine and allow it to cool until the fluid temp drops below 30°C then restart the procedure from step 11.*

16. Remove the filler plug, the fluid level should be level with the bottom of the plug
17. If the level is low, top up with fluid until the correct level is achieved

Note: *If more than 500mls of fluid is required to reach the correct level, return to step 12!*

18. Tighten the filler plug to the specified torque.

Note: *Ford states that the filler/level plug is single use and should be replaced!*

FORD FALCON (FG) – 6 SPEED continued...

Specifications

Torque Settings

Item	Torque Specification
Polyamide Pan	10Nm
Steel Pan	12Nm
Drain Plug (if applicable)	8Nm
Filler/Level Plug	35Nm

Table 10: Ford Falcon (FG) – 6 speed, Transmission service torque specifications

Service Kit

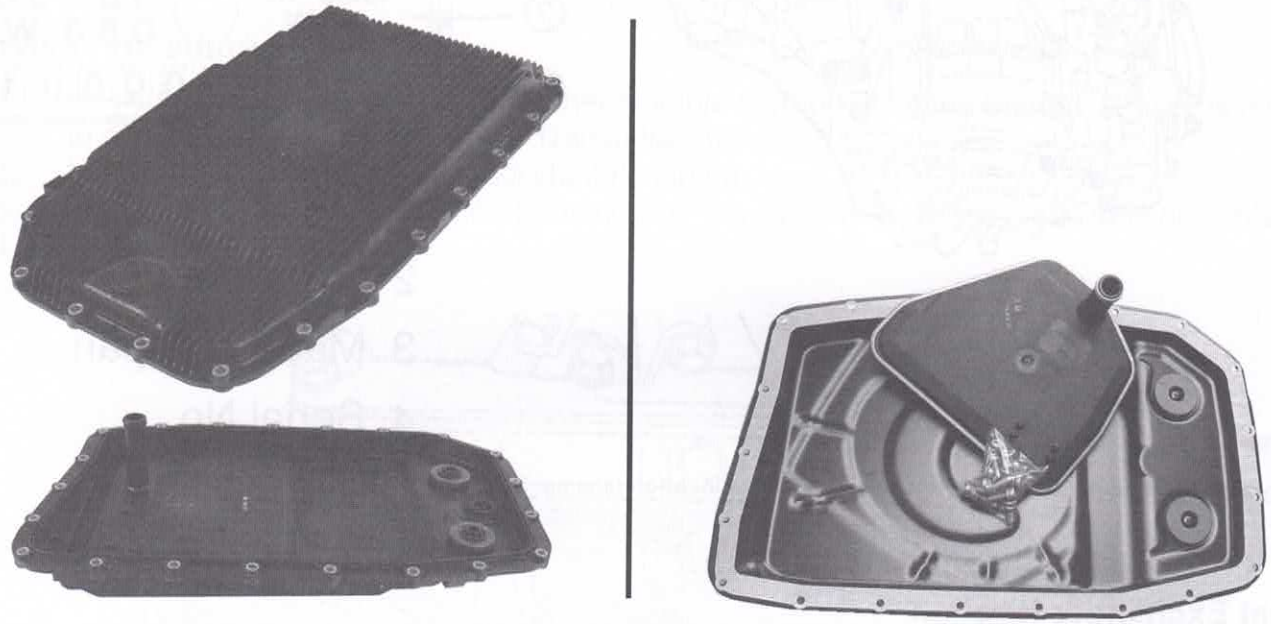


Diagram: 24: Ford Falcon (FG) – 6 speed, Plastic Pan with Rubber gasket (left) and Steel Pan with Fibre gasket (right)

Fluid Type and Quantities

Shell M1375.4 or licensed equivalent

Procedure	Fluid Quantity
Service Fill	approximately 5.5L
Dry Fill	approximately 10L

Table 11: Ford Falcon (FG) – 6 speed, Transmission fluid quantities

Time Guide

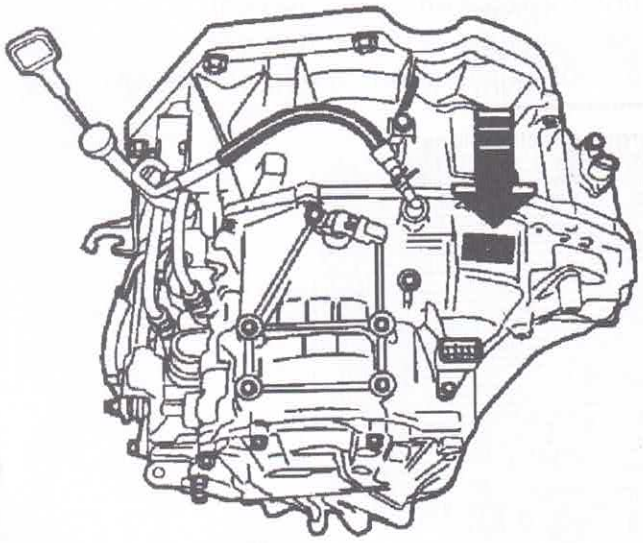
Procedure	Time
Automatic Transmission Service (inc. Filter)	1.7 hours

Table 12: Ford Falcon (FG) – 6 speed, Transmission times guide

HOLDEN BARINA (TK) – 4 SPEED

The TK series Holden Barina is available with a 4 speed automatic transmission that is designed and built by Aisin AW. The transmission was introduced in 2005 and used through until 2011.

ID Plate location



1 Model No.
2 Manufacturer
3 Made in Japan
4 Serial No.

Diagram: 25: Holden Barina (TK) – 4 speed, ID Plate location (source: GM)

Heat Exchanger location

The transmission heat exchanger is a pass through, incorporated into the radiator.

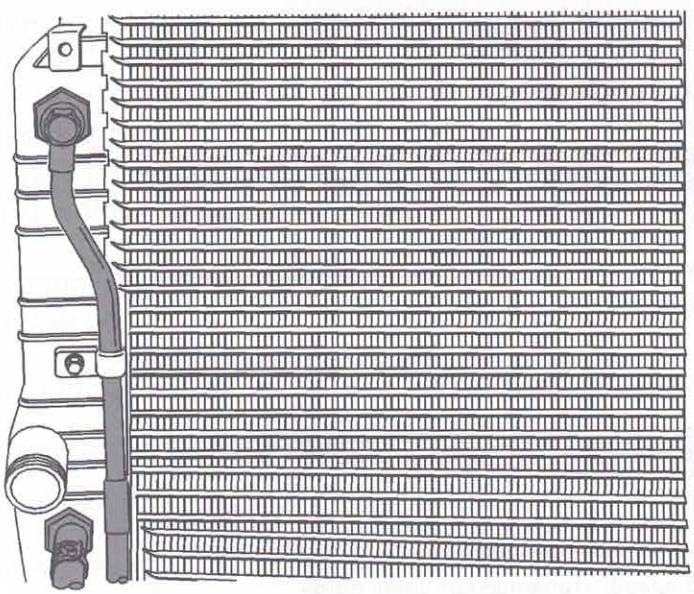


Diagram: 26: Holden Barina (TK) – 4 speed, heat exchanger pipe location (source: GM)

HOLDEN BARINA (TK) – 4 SPEED continued...

Service Schedule

Vehicle	Inspect (km/yrs)	Normal Service (km/yrs)	Severe Service (km/yrs)
Holden Barina (TK)	Not Specified	Not Required	60,000km

Table 13: Holden Barina (TK) – 4 speed, Transmission service schedule

Note: *Automatic transmission service intervals should be assessed on a case by case basis, taking into account the manufacturer's recommendations, the driving conditions, the service history as well as any other fluid condition reports available.*

Service Procedure

1. Position the vehicle on a hoist or other suitable method ensuring that the vehicle is level to allow access to the Automatic Transmission
2. Isolate the vehicle to prevent accidental starting
3. Place a oil catch tray under the transmission (as close to the transmission as possible)
4. Remove the drain plug

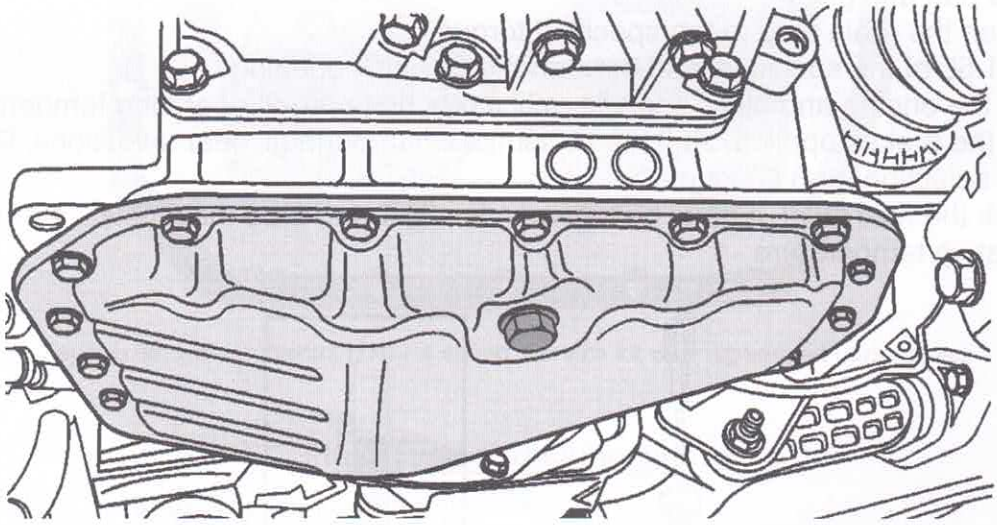


Diagram: 27: Holden Barina (TK) – 4 speed, drain plug and pan (source: GM)

5. Loosen the pan
6. Using a suitable prying tool, carefully release one side of the transmission pan
7. Once drained, remove the remaining pan bolts and the pan
8. Clean the gasket residue from the sealing surfaces, wash out the pan and clean the magnets of any residue
9. Remove the transmission filter and gasket

HOLDEN BARINA (TK) – 4 SPEED continued...

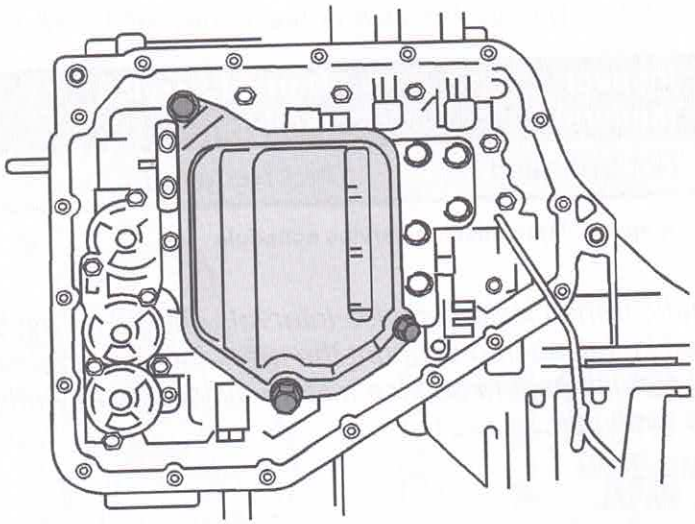


Diagram: 28: Holden Barina (TK) – 4 speed, transmission filter (source: GM)

10. Fit the new transmission filter and gasket and tighten to the specified torque
11. Fit the pan with a new gasket and tighten the bolts until they are just in contact with the pan
12. Tighten the pan to the specified torque, working evenly across the pan to avoid damage to the pan and gasket
13. Tighten the drain plug to the specified torque
14. Add 1.5L of the specified fluid through the dip stick opening
15. Start the engine and allow it to idle until it reaches normal operating temperature
16. With the brakes applied, shift the transmission through all gear selections. Pausing in each selection for 3 seconds
17. Check the fluid level, it must be between levels 1 and 2 on the dipstick at normal operating temperature

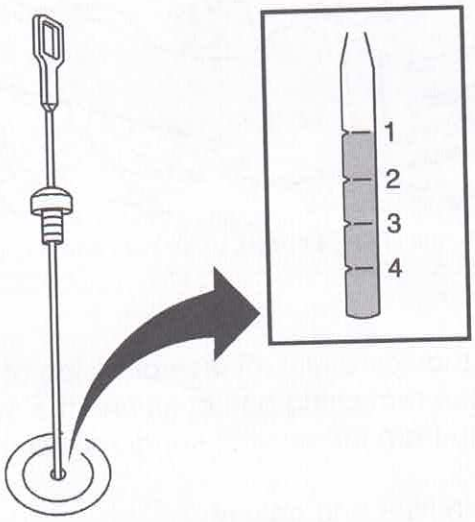


Diagram: 29: Holden Barina (TK) – 4 speed, fluid level (source: GM)

18. Top up fluid until the required level is achieved.

HOLDEN BARINA (TK) – 4 SPEED continued...

Specifications

Torque Settings

Item	Torque Specification
Transmission Filter	10Nm
Transmission Pan	7.5Nm
Drain Plug	17Nm

Table 14: Holden Barina (TK) – 4 speed, Transmission service torque specifications

Service Kit

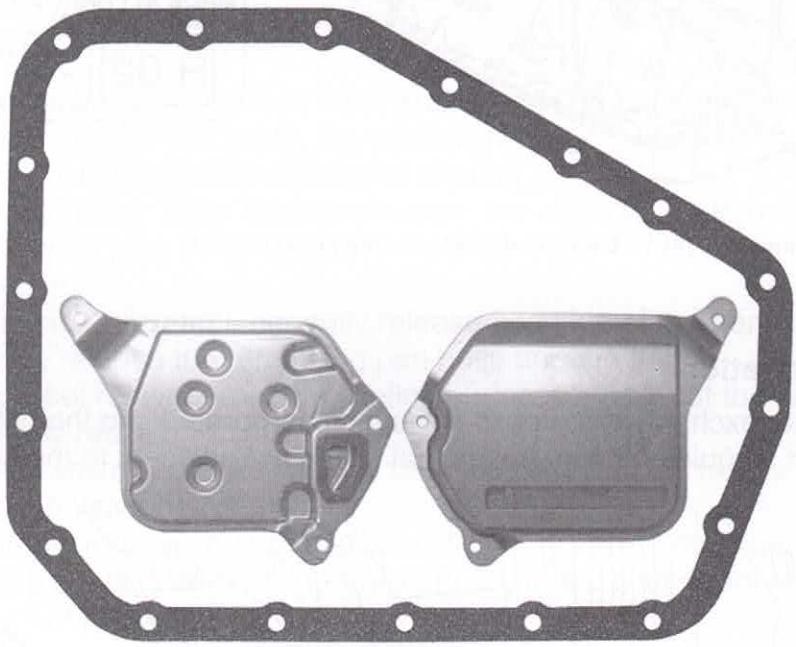


Diagram 30: Holden Barina (TK) – 4 speed, Service kit with rubberised cork gasket

Fluid Type and Quantities

Mobil ATF™ 3309 or other licensed equivalent

Procedure	Fluid Quantity
Service Fill	2.1L
Dry Fill	5.8L

Table 15: Holden Barina (TK) – 4 speed, Transmission fluid quantities

Time Guide

Procedure	Time
Automatic Transmission Drain and Refill	0.5 hours
Automatic Transmission Service (inc. Filter)	Approximately 1.5 hours

Table 16: Holden Barina (TK) – 4 speed, Transmission times guide

HOLDEN COMMODORE (VE) – 5 SPEED

The VE series Holden Commodore is available with a 5 speed automatic transmission that is designed and built by GM. The transmission was introduced in 2006 and is still current.

ID Plate location

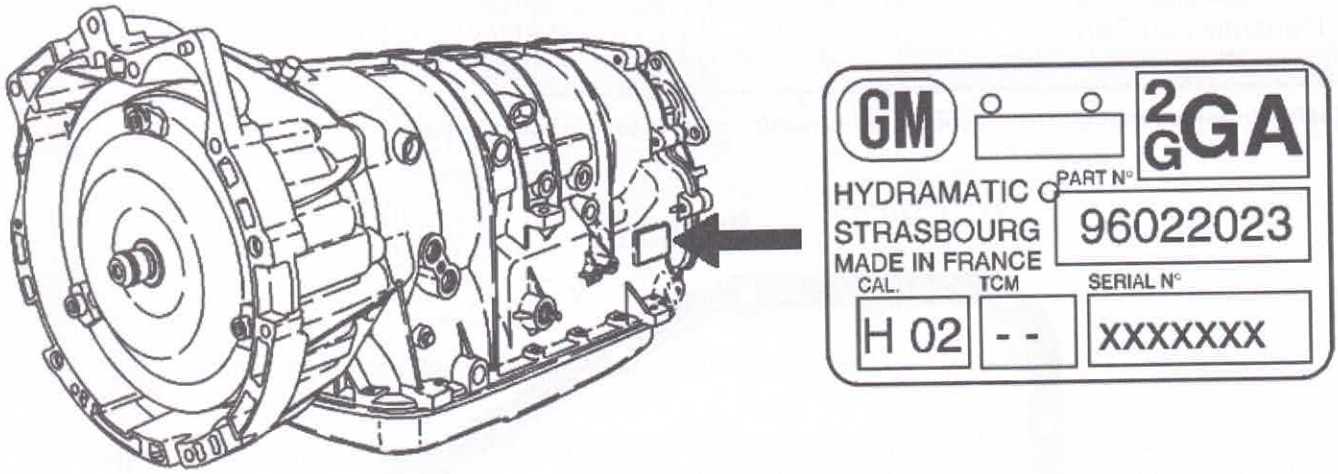


Diagram: 31: Holden Commodore (VE) – 5 speed, ID Plate location (source: GM)

Heat Exchanger location

The transmission heat exchanger is a pass through, incorporated into the bottom tank of the radiator, it is connect by quick release hoses that are found adjacent to the crankshaft pulley.

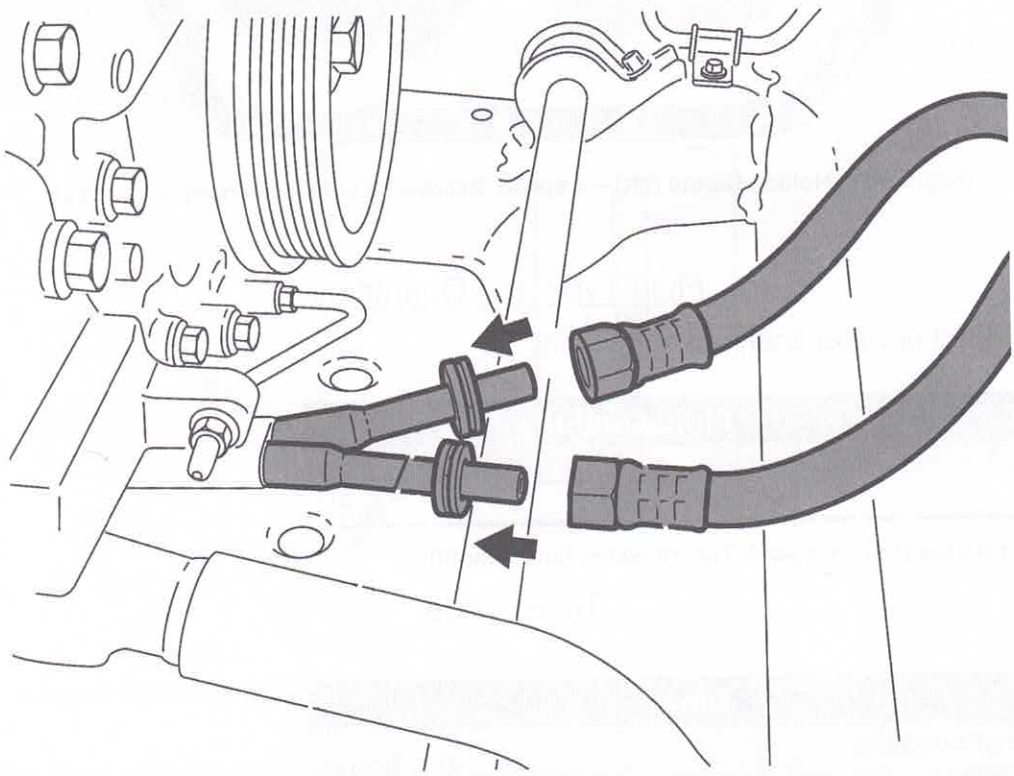


Diagram: 32: Holden Commodore (VE) – 5 speed, heat exchanger pipe location (source: GM)

HOLDEN COMMODORE (VE) – 5 SPEED continued...

Service Schedule

Vehicle	Inspect (km/yrs)	Normal Service (km/yrs)	Severe Service (km/yrs)
Holden Commodore (VE)	15,000km / 1yr	150,000km / 7.5yrs	75,000km / 3.75yrs

Table 17: Holden Commodore (VE) – 5 speed, Transmission service schedule

Note: *Automatic transmission service intervals should be assessed on a case by case basis, taking into account the manufacturer's recommendations, the driving conditions, the service history as well as any other fluid condition reports available.*

Service Procedure

1. Position the vehicle on a hoist or other suitable method ensuring that the vehicle is level to allow access to the Automatic Transmission
2. Isolate the vehicle to prevent accidental starting
3. Place a oil catch tray under the transmission (as close to the transmission as possible)
4. Remove the drain plug (see *Item 63* in *Diagram 34*)
5. Loosen the pan
6. Using a suitable prying tool, carefully release one side of the transmission pan
7. Once drained, remove the remaining pan bolts and the pan
8. Clean the gasket residue from the sealing surfaces, wash out the pan and clean the magnets of any residue
9. Remove the transmission filter (it may take a little prying to release the filter neck from the seals in the valve body)
10. Using a suitable tool, remove the lip seals from the valve body fluid inlet
11. Fit the new lip seals (see *Item 1* in *Diagram 33*) to the filter spout and lubricate with a small amount of petroleum jelly

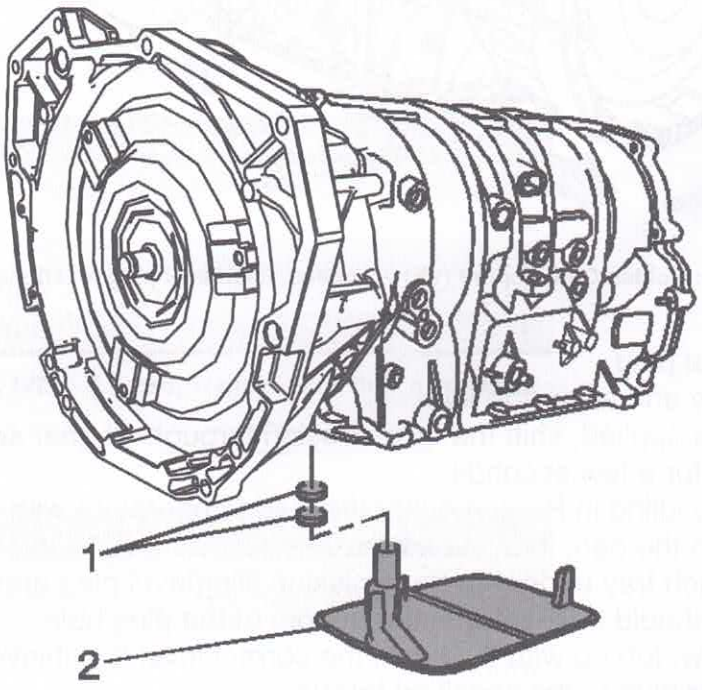


Diagram: 33: Holden Commodore (VE) – 5 speed, filter with seals (source: GM)

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HOLDEN COMMODORE (VE) – 5 SPEED continued...

12. Carefully fit the new transmission filter, taking care not to cut the lip seals on any sharp edges
13. Fit the pan and gasket, tighten the bolts until they are just in contact with the pan
14. Tighten the pan to the specified torque, working evenly across the pan to avoid damage to the pan and gasket
15. Tighten the drain plug to the specified torque

Note: Holden states that the drain plug is single use and should be replaced!

16. Add the specified fluid through one of the filler/level plug holes (see *Item 36* in *Diagram 34*) until the fluid is level with the bottom of the hole

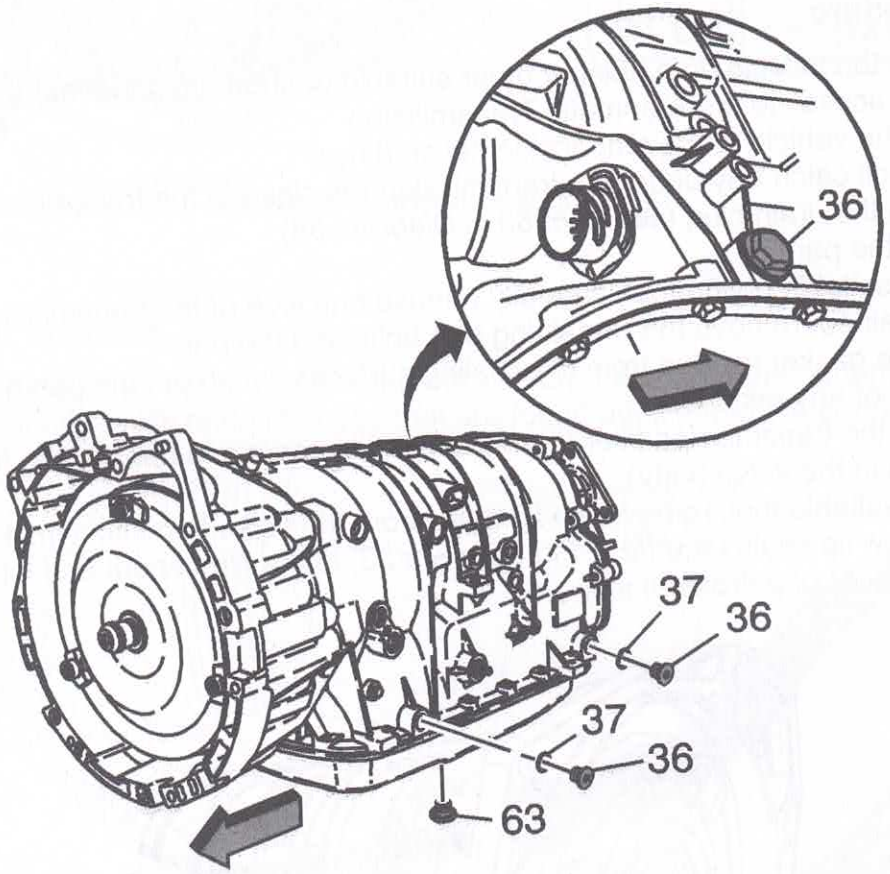

Diagram: 34: Holden Commodore (VE) – 5 speed, filler/level plug locations (source: GM)

17. Fit the filler/level plug
18. Start the engine and allow it to idle
19. With the brakes applied, shift the transmission through all gear selections. Pausing in each selection for a few seconds.
20. With the engine idling in Park, monitor the fluid temperature with a Scan Tool or infrared thermometer on the pan, it must be between 30°C and 50°C
21. Place an oil catch tray under the transmission filler/level plug and remove the plug
22. The fluid level should be level with the bottom of the plug hole
23. If the level is low, top up with fluid until the correct level is achieved
24. Tighten the filler plug to the specified torque.

HOLDEN COMMODORE (VE) – 5 SPEED continued...

Specifications

Torque Settings

Item	Torque Specification
Filler/Level Plug	20Nm
Transmission Pan	11Nm
Drain Plug	20Nm

Table 18: Holden Commodore (VE) – 5 speed, Transmission service torque specifications

Service Kit

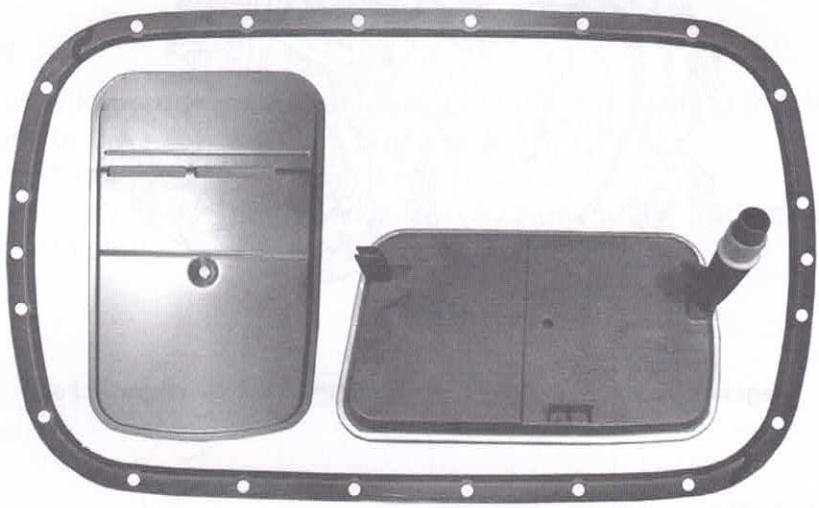

Diagram 35: Holden Commodore (VE) – 5 speed, Service kit with rubber gasket

Fluid Type and Quantities

Dexron® VI or other licensed equivalent

Procedure	Fluid Quantity
Service Fill	7.0L
Overhaul Fill	8.5L
Dry Fill	8.9L
245mm Torque Converter	2.9L
258mm Torque Converter	3.1L

Table 19: Holden Commodore (VE) – 5 speed, Transmission fluid quantities

Time Guide

Procedure	Time
Automatic Transmission Drain and Refill	Approximately 0.5 hours
Automatic Transmission Service (inc. Filter)	1.0 hours

Table 20: Holden Commodore (VE) – 5 speed, Transmission times guide

MAZDA 3 (BK) – 5 SPEED

The BK series Mazda 3 is available with a 5 speed automatic transmission that is designed and built by Jatco. The transmission was introduced in 2004 and was used until 2009.

ID Plate location

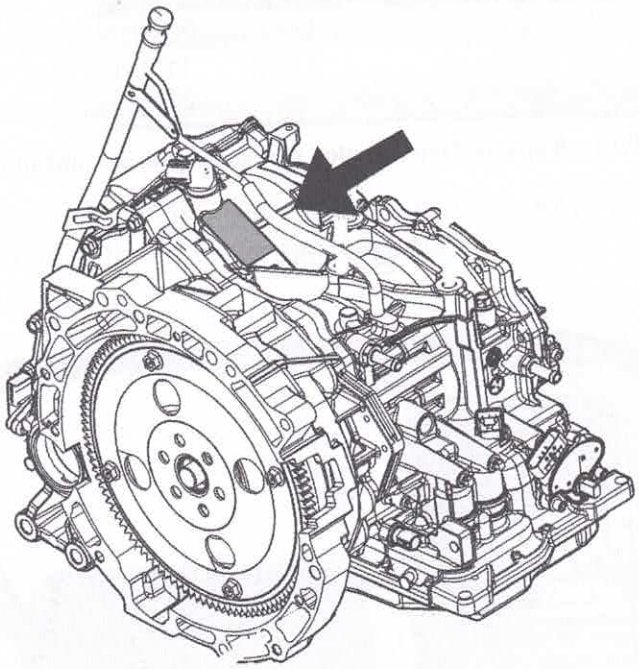

Diagram: 36: Mazda 3 (BK) – 5 speed, ID Plate location (source: Ford)

Heat Exchanger location

The transmission heat exchanger is located on the front of the transverse transmission.

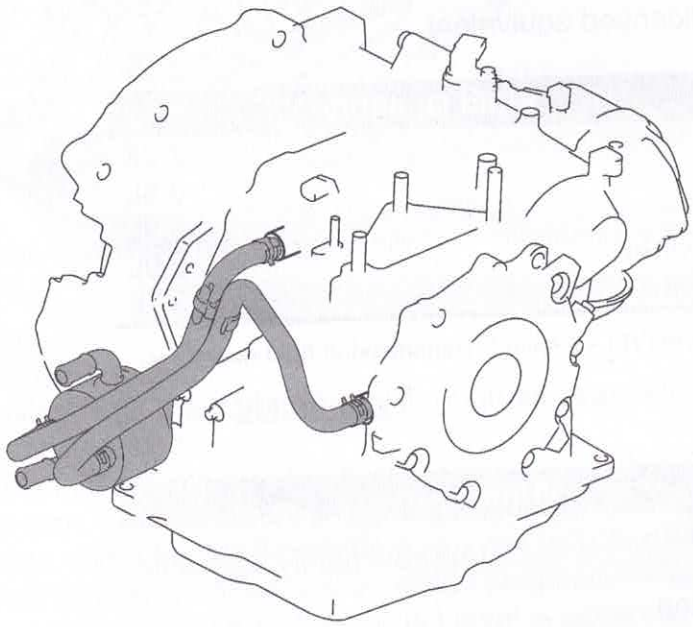

Diagram: 37: Mazda 3 (BK) – 5 speed, heat exchanger pipe location (source: Mazda)

MAZDA 3 (BK) – 5 SPEED continued...

Service Schedule

Vehicle	Inspect (km/yrs)	Normal Service (km/yrs)	Severe Service (km/yrs)
Mazda 3 (BK)	20,000km / 1yr	Not Required	Not Specified

Table 21: Mazda 3 (BK) – 5 speed, Transmission service schedule

Note: *Automatic transmission service intervals should be assessed on a case by case basis, taking into account the manufacturer's recommendations, the driving conditions, the service history as well as any other fluid condition reports available.*

Service Procedure

1. Position the vehicle on a hoist or other suitable method ensuring that the vehicle is level to allow access to the Automatic Transmission
2. Isolate the vehicle to prevent accidental starting
3. Place a oil catch tray under the transmission (as close to the transmission as possible)
4. Remove the drain plug

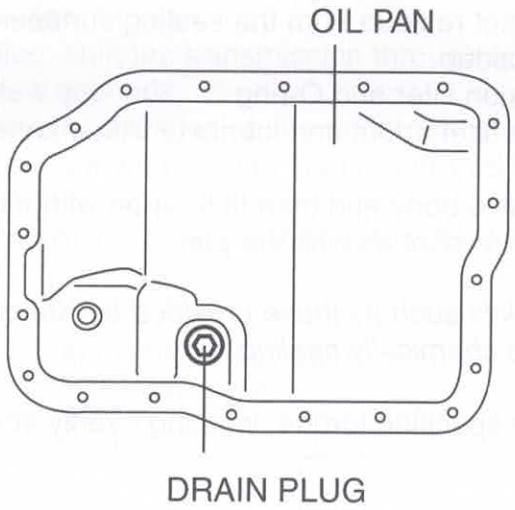

Diagram: 38: Mazda 3 (BK) – 5 speed, drain plug and pan (source: Mazda)

5. Loosen the pan

MAZDA 3 (BK) – 5 SPEED continued...

6. Using a suitable prying tool, carefully release one side of the transmission pan

Caution: The transmission pan is chemically sealed from the factory, Auto-Tech recommends using a specially designed tool to prevent damage to the pan or transmission case!

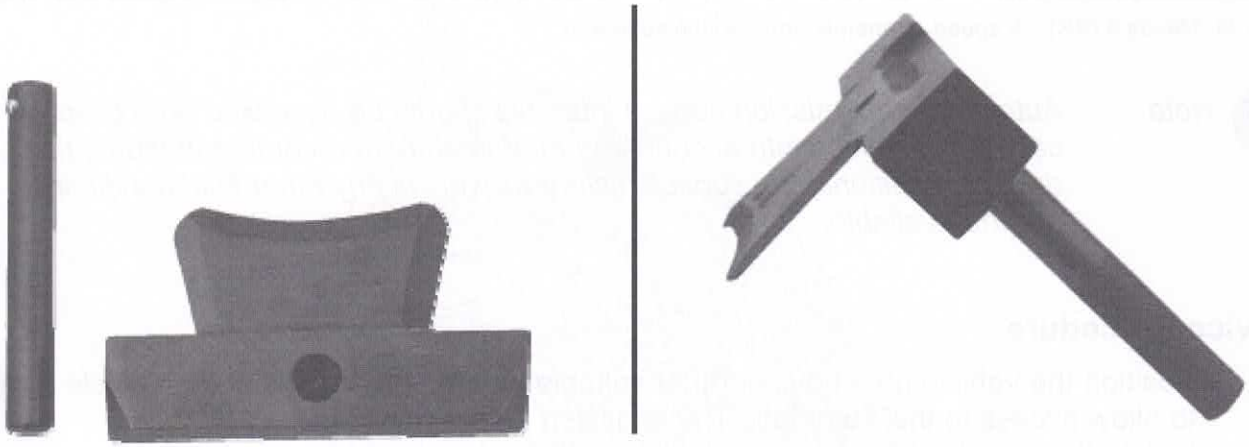

Diagram: 39: Pan Separator Tool (source: Repco)

7. Once drained, remove the remaining pan bolts and the pan
8. Clean the sealant/gasket residue from the sealing surfaces, wash out the pan and clean the magnets of any residue
9. Remove the transmission filter and O-ring
10. Fit a new O-ring to the filter spout and lubricate with a small amount of transmission fluid
11. Fit the filter into the valve body and then fit the pan with a new gasket and tighten the bolts until they are just in contact with the pan

Note: Aftermarket kits such as those provided by Repco include a pan gasket as an alternative to chemically sealing.

12. Tighten the pan to the specified torque, working evenly across the pan to damage to the pan and gasket

MAZDA 3 (BK) – 5 SPEED continued...

13. Tighten the drain plug to the specified torque

Note: Mazda recommends replacing the drain plug washer!

14. Add enough of the specified fluid through the dip stick tube so that it registers on the bottom of the dipstick (see *Diagram 40*)

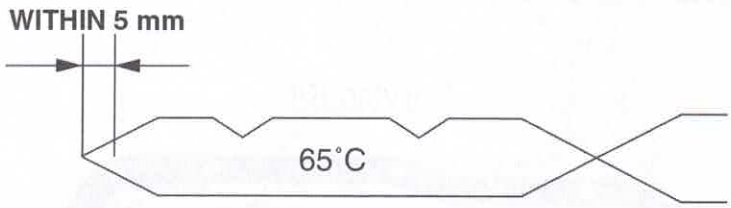

Diagram: 40: Mazda 3 (BK) – 5 speed, minimum fluid level (source: Mazda)

Caution: Starting the engine without sufficient fluid in the transmission can cause severe damage to the transmission unit!

15. Start the engine and allow it to idle
16. With the brakes applied, shift the transmission through all gear selections. Pausing in each selection for a few seconds
17. Drive the vehicle in an urban driving environment for at least 5km
18. Check the fluid temperature with a Scan Tool or infrared thermometer on the pan, it must be between 60°C and 70°C
19. With the engine idling the fluid level must be within the level as specified on the dipstick (see *Diagram 41*)

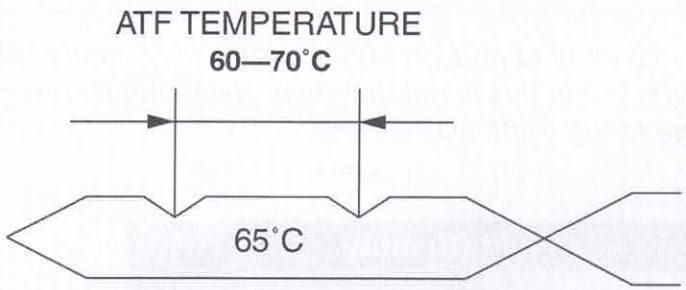

Diagram: 41: Mazda 3 (BK) – 5 speed, normal fluid level range (source: Mazda)

20. If the level is low, top up with fluid until the correct level is achieved

MAZDA 3 (BK) – 5 SPEED continued...

Specifications

Torque Settings

Item	Torque Specification
Drain Plug	30-41Nm
Transmission Pan	6-8Nm

Table 22: Mazda 3 (BK) – 5 speed, Transmission service torque specifications

Service Kit

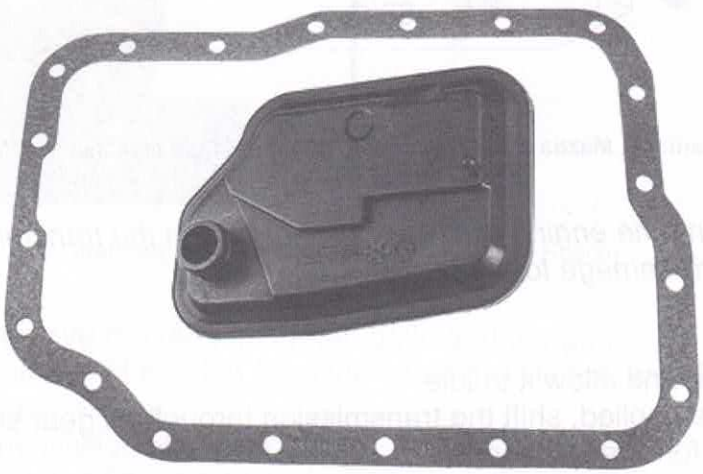

Diagram 42: Mazda 3 (BK) – 5 speed, Service kit with rubberised cork gasket

Fluid Type and Quantities

Mazda M-V, Ford FNR-5 or licensed equivalent

Caution: There is a lot of confusion about Mazda M-V, many believe it is the same as Mercon® V, but this is not the case. Using the incorrect fluid can cause severe damage to the transmission unit!

Procedure	Fluid Quantity
Service Fill	3.0L
Dry Fill	5.0L

Table 23: Mazda 3 (BK) – 5 speed, Transmission fluid quantities

Time Guide

Procedure	Time
Automatic Transmission Drain and Refill	0.5 hours
Automatic Transmission Service (inc. Filter)	Approximately 1.5 hours

Table 24: Mazda 3 (BK) – 5 speed, Transmission times guide

TOYOTA CAMRY (ACV40) – 5 SPEED

The ACV40 series Toyota Camry is available with a 5 speed automatic transmission that is designed and built by Aisin AW. The transmission was introduced in 2006 and was used until the start of 2012.

ID Plate location

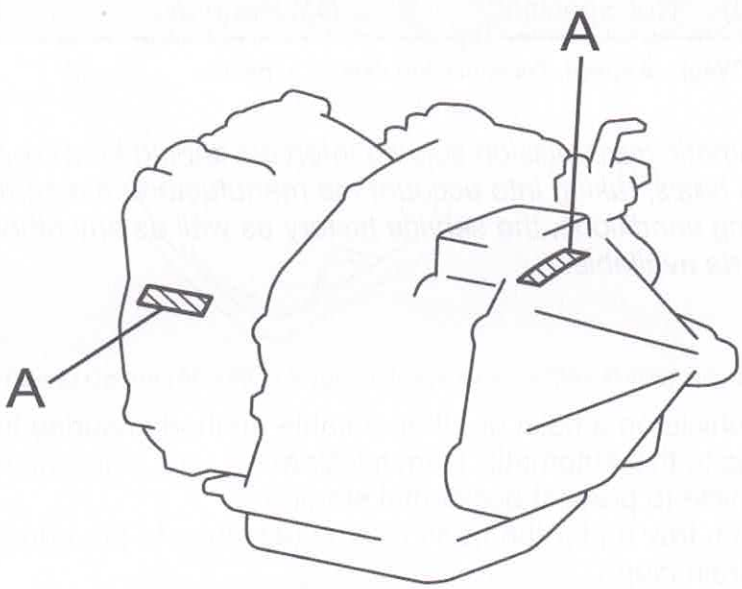

Diagram: 43: Toyota Camry (ACV40) – 5 speed, ID Plate location (source: Toyota)

Heat Exchanger location

The transmission heat exchanger is a pass through, incorporated into the bottom tank of the radiator.

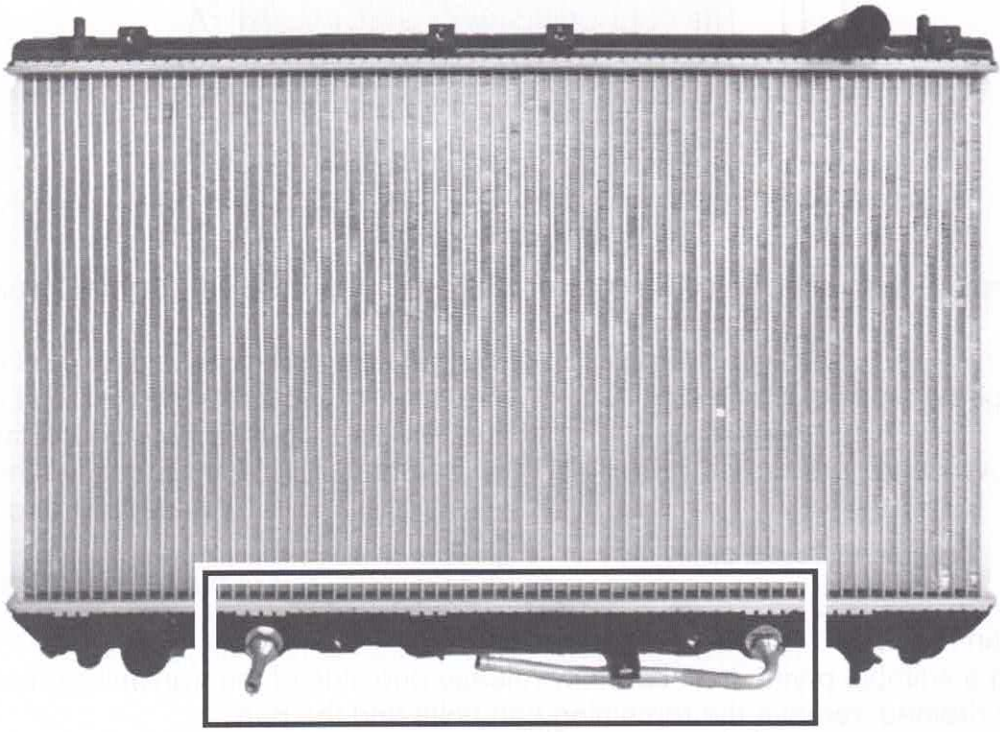

Diagram: 44: Toyota Camry (ACV40) – 5 speed, heat exchanger location

TOYOTA CAMRY (ACV40) – 5 SPEED continued...

Service Schedule

Vehicle	Inspect (km/yrs)	Normal Service (km/yrs)	Severe Service (km/yrs)
Toyota Camry (ACV40)	Not Specified	Not Required	90,000km

Table 15: Toyota Camry (ACV40) – 5 speed, Transmission service schedule

Note: *Automatic transmission service intervals should be assessed on a case by case basis, taking into account the manufacturer's recommendations, the driving conditions, the service history as well as any other fluid condition reports available.*

Service Procedure

1. Position the vehicle on a hoist or other suitable method ensuring that the vehicle is level to allow access to the Automatic Transmission
2. Isolate the vehicle to prevent accidental starting
3. Place a oil catch tray under the transmission (as close to the transmission as possible)
4. Remove the drain plug

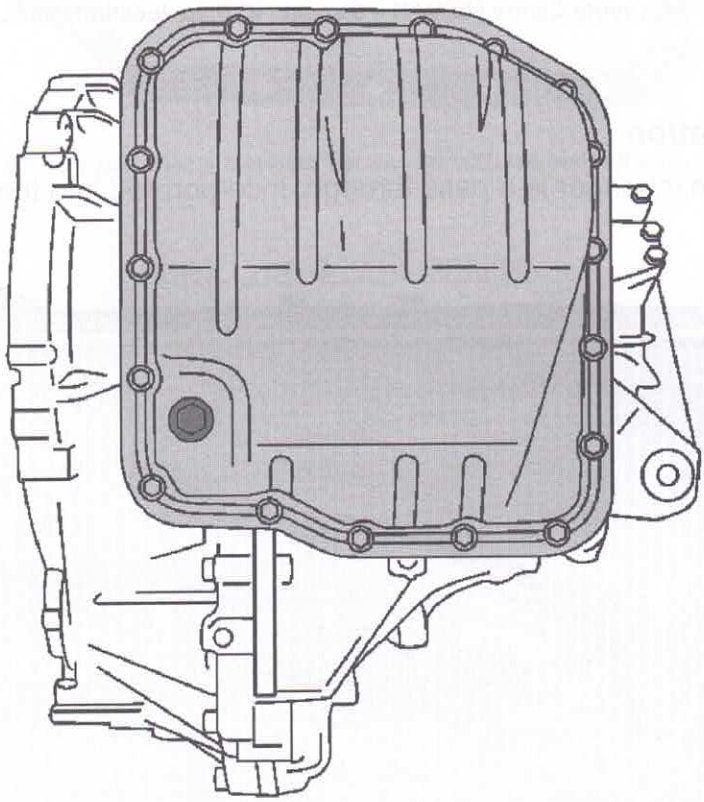

Diagram: 45: Toyota Camry (ACV40) – 5 speed, drain plug and pan (source: Toyota)

5. Loosen the pan
6. Using a suitable prying tool, carefully release one side of the transmission pan
7. Once drained, remove the remaining pan bolts and the pan
8. Clean the gasket residue from the sealing surfaces, wash out the pan and clean the magnets of any residue

TOYOTA CAMRY (ACV40) – 5 SPEED continued...

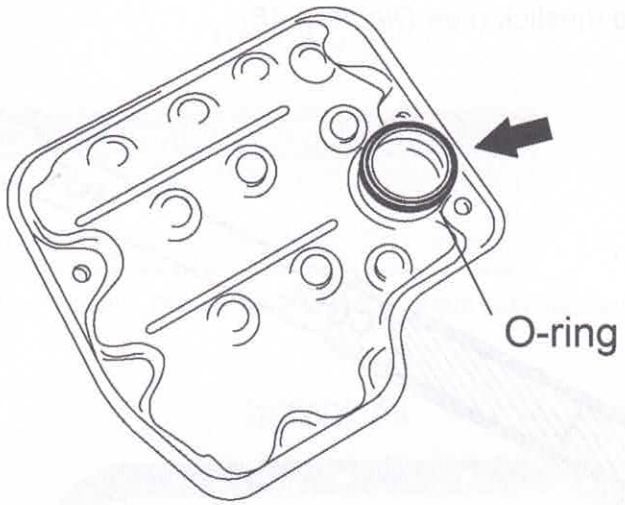

Diagram: 46: Toyota Camry (ACV40) – 5 speed, transmission filter O-ring (source: Toyota)

9. Remove the transmission filter and O-ring

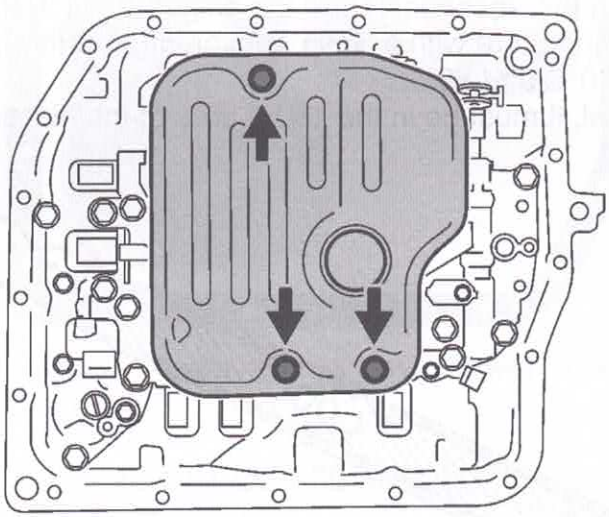

Diagram: 47: Toyota Camry (ACV40) – 5 speed, transmission filter (source: Toyota)

10. Fit a new O-ring to the filter spout and lubricate with a small amount of transmission fluid
11. Fit the new transmission filter and tighten to the specified torque
12. Fit the filter into the valve body and then fit the pan with a new gasket and tighten the bolts until they are just in contact with the pan
13. Tighten the pan to the specified torque, working evenly across the pan to avoid damage to the pan and gasket

14. Tighten the drain plug to the specified torque

Note: Toyota recommends replacing the drain plug washer!

TOYOTA CAMRY (ACV40) – 5 SPEED continued...

15. Add enough of the specified fluid through the dip stick tube so that it registers in the 'COOL' area of the dipstick (see *Diagram 48*)

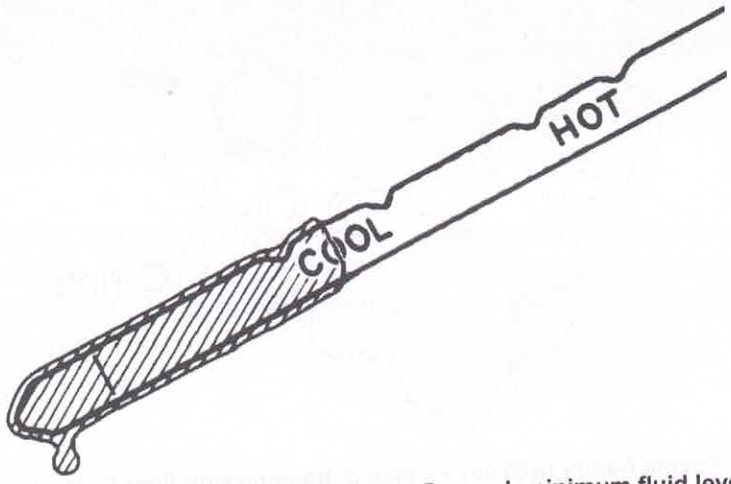

Diagram: 48: Toyota Camry (ACV40) – 5 speed, minimum fluid level

16. Start the engine and allow it to idle until it reaches normal operating temperature
17. With the brakes applied, shift the transmission through all gear selections. Pausing in each selection for a few seconds, return the shifter to the 'Park' position
18. Check the fluid temperature with a Scan Tool or infrared thermometer on the pan, it must be between 70°C and 80°C
19. Check the fluid level, it must be in the 'HOT' area of the dipstick (see *Diagram 49*)

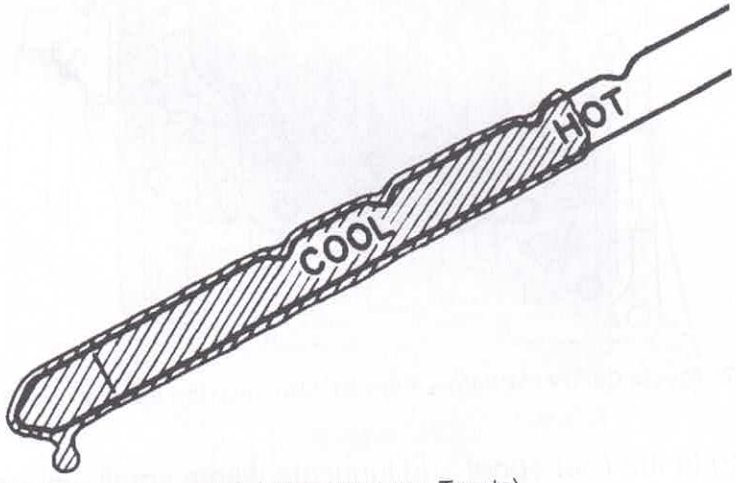

Diagram: 49: Toyota Camry (ACV40) – 5 speed, fluid level (source: Toyota)

20. Top up fluid until the required level is achieved.

TOYOTA CAMRY (ACV40) – 5 SPEED continued...

Specifications

Torque Settings

Item	Torque Specification
Transmission Filter	11Nm
Transmission Pan	7.8Nm
Drain Plug	49Nm

Table 26: Toyota Camry (ACV40) – 5 speed, Transmission service torque specifications

Service Kit

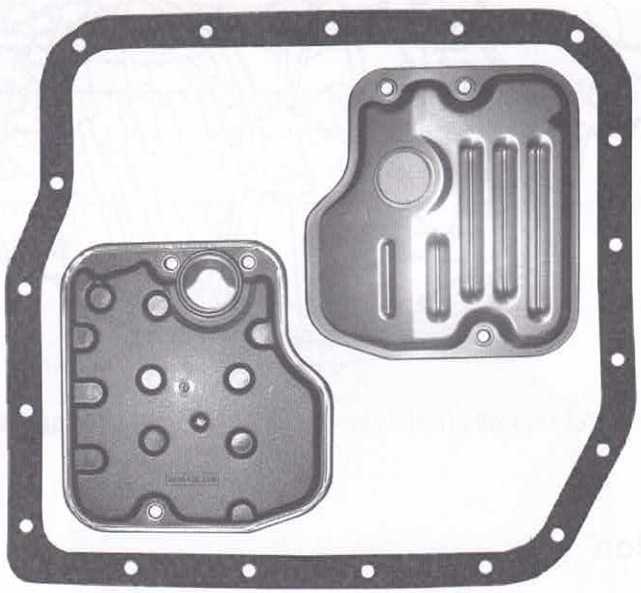

Diagram 50: Toyota Camry (ACV40) – 5 speed, Service kit with rubberised cork gasket

Fluid Type and Quantities

Mobil ATF™ 3309 or other licensed equivalent

Procedure	Fluid Quantity
Service Fill	3.5L
Dry Fill	8.0L

Table 27: Toyota Camry (ACV40) – 5 speed, Transmission fluid quantities

Time Guide

Procedure	Time
Automatic Transmission Drain and Refill	0.8 hours
Automatic Transmission Service (inc. Filter)	Approximately 1.5 hours

Table 28: Toyota Camry (ACV40) – 5 speed, Transmission times guide

TOYOTA COROLLA (ZRE152) – 4 SPEED

The ZRE152 series Toyota Corolla is available with a 4 speed automatic transmission that is designed and built by Aisin AW. The transmission was introduced in 2007 and is still current.

ID Plate location

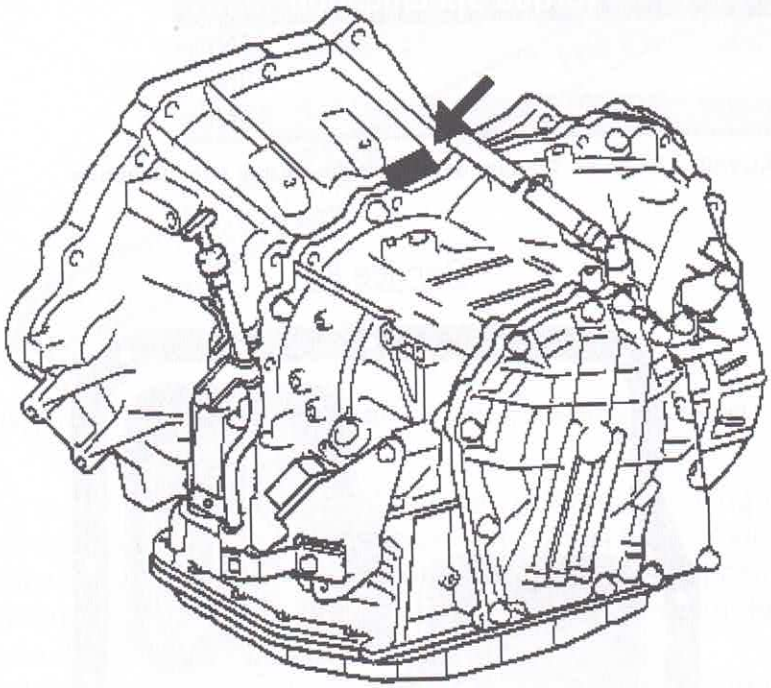

Diagram: 51: Toyota Corolla (ZRE152) – 4 speed, ID Plate location (source: Toyota)

Heat Exchanger location

The transmission heat exchanger is a pass through, incorporated into the bottom tank of the radiator.

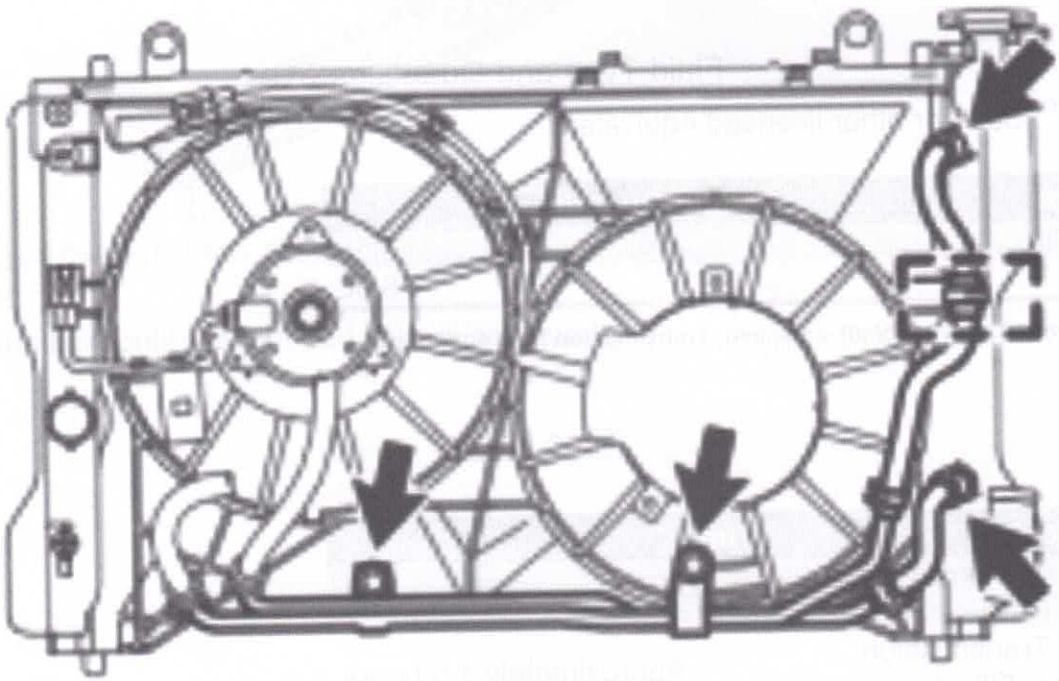

Diagram: 52: Toyota Corolla (ZRE152) – 4 speed, heat exchanger location (source: Toyota)

TOYOTA COROLLA (ZRE152) – 4 SPEED continued...

Service Schedule

Vehicle	Inspect (km/yrs)	Normal Service (km/yrs)	Severe Service (km/yrs)
Toyota Corolla (ZRE152)	Not Specified	Not Required	80,000km / 4yrs

Table 29: Toyota Corolla (ZRE152) – 4 speed, Transmission service schedule

Note: *Automatic transmission service intervals should be assessed on a case by case basis, taking into account the manufacturer's recommendations, the driving conditions, the service history as well as any other fluid condition reports available.*

Service Procedure

1. Position the vehicle on a hoist or other suitable method ensuring that the vehicle is level to allow access to the Automatic Transmission
2. Isolate the vehicle to prevent accidental starting
3. Place a oil catch tray under the transmission (as close to the transmission as possible)
4. Remove the drain plug

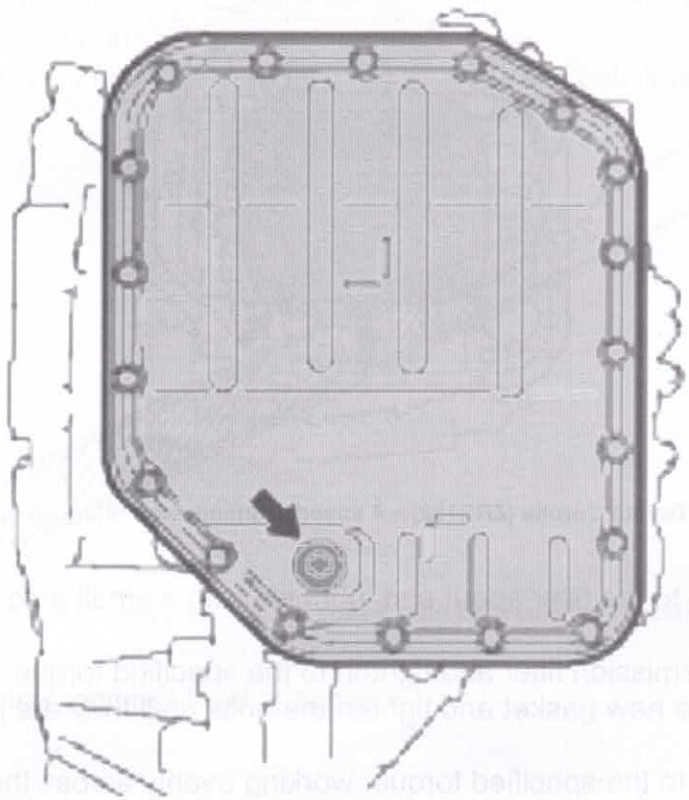

Diagram: 53: Toyota Corolla (ZRE152) – 4 speed, drain plug and pan (source: Toyota)

5. Loosen the pan
6. Using a suitable prying tool, carefully release one side of the transmission pan
7. Once drained, remove the remaining pan bolts and the pan
8. Clean the gasket residue from the sealing surfaces, wash out the pan and clean the magnets of any residue

TOYOTA COROLLA (ZRE152) – 4 SPEED continued...

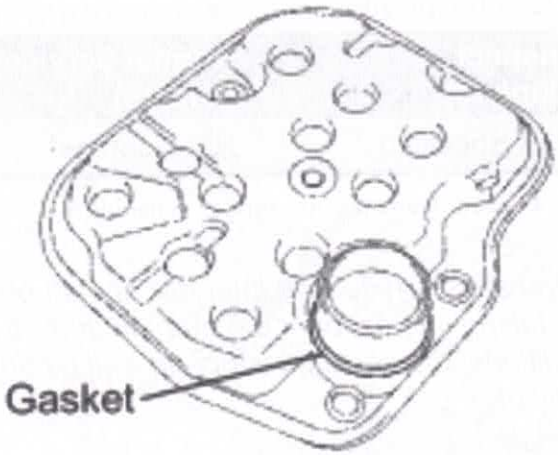

Diagram: 54: Toyota Corolla (ZRE152) – 4 speed, transmission filter O-ring (source: Toyota)

9. Remove the transmission filter and O-ring

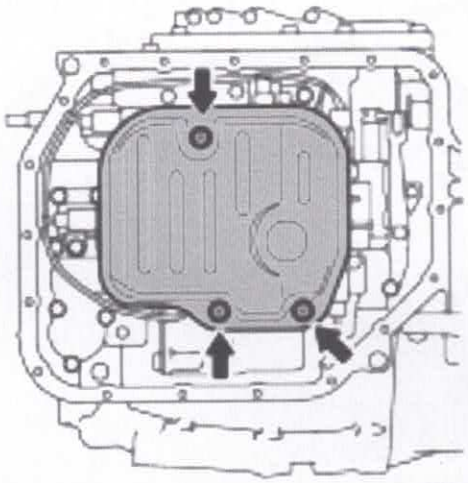

Diagram: 55: Toyota Corolla (ZRE152) – 4 speed, transmission filter (source: Toyota)

10. Fit a new O-ring to the filter spout and lubricate with a small amount of transmission fluid
11. Fit the new transmission filter and tighten to the specified torque
12. Fit the pan with a new gasket and tighten the bolts until they are just in contact with the pan
13. Tighten the pan to the specified torque, working evenly across the pan to avoid damage to the pan and gasket

14. Tighten the drain plug to the specified torque

Note: Toyota recommends replacing the drain plug washer!

TOYOTA COROLLA (ZRE152) – 4 SPEED continued...

15. Add enough of the specified fluid through the dip stick tube so that it registers in the 'COOL' area of the dipstick (see *Diagram 56*)

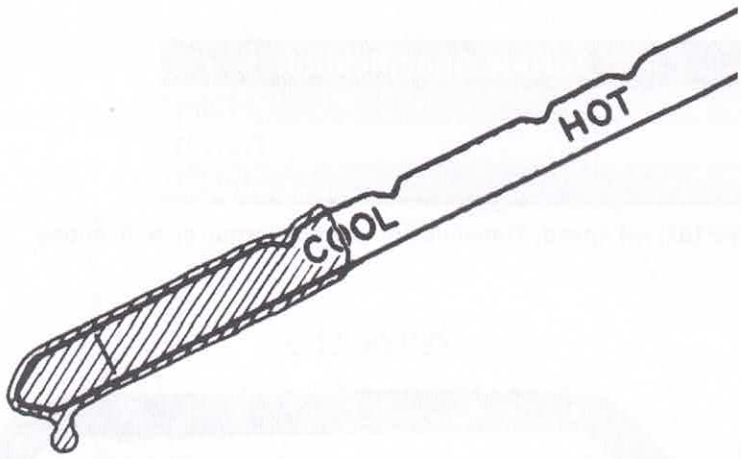

Diagram: 56: Toyota Corolla (ZRE152) – 4 speed, minimum fluid level

16. Start the engine and allow it to idle until it reaches normal operating temperature
17. With the brakes applied, shift the transmission through all gear selections. Pausing in each selection for a few seconds, return the shifter to the 'Park' position
18. Check the fluid temperature with a Scan Tool or infrared thermometer on the pan, it must be between 70°C and 80°C
19. Check the fluid level, it must be in the 'HOT' area of the dipstick (see *Diagram 57*)

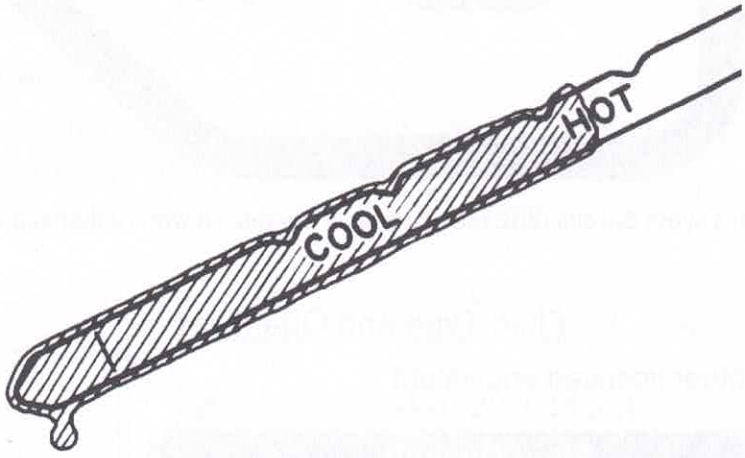

Diagram: 57: Toyota Corolla (ZRE152) – 4 speed, fluid level (source: Toyota)

20. Top up fluid until the required level is achieved.

TOYOTA COROLLA (ZRE152) – 4 SPEED continued...

Specifications

Torque Settings

Item	Torque Specification
Transmission Filter	11Nm
Transmission Pan	7.8Nm
Drain Plug	49Nm

Table 20: Toyota Corolla (ZRE152) – 4 speed, Transmission service torque specifications

Service Kit

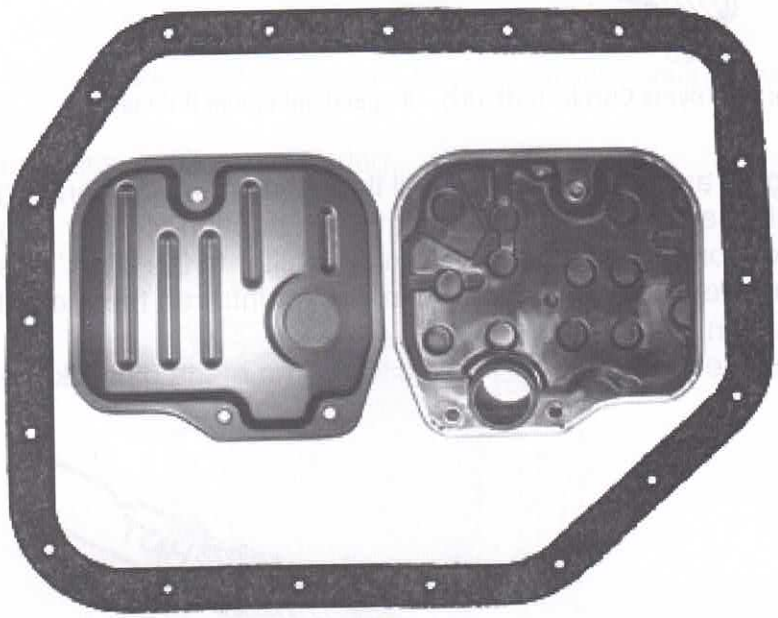

Diagram 58: Toyota Corolla (ZRE152) – 4 speed, Service kit with rubberised cork gasket

Fluid Type and Quantities

Mobil ATF™ 3324 or other licensed equivalent

Procedure	Fluid Quantity
Service Fill	2.5-3.5L

Table 21: Toyota Corolla (ZRE152) – 4 speed, Transmission fluid quantities

Time Guide

Procedure	Time
Automatic Transmission Drain and Refill	Approximately 0.8 hours
Automatic Transmission Service (inc. Filter)	2.1 hours

Table 22: Toyota Corolla (ZRE152) – 4 speed, Transmission times guide

TOYOTA PRADO (120 SERIES) – 5 SPEED

The GJR120 & KDJ120 series Toyota Prado's are available with a 5 speed automatic transmission that is designed and built by Aisin AW. The transmission was introduced into the Prado in 2004 and was used until 2009.

ID Plate location

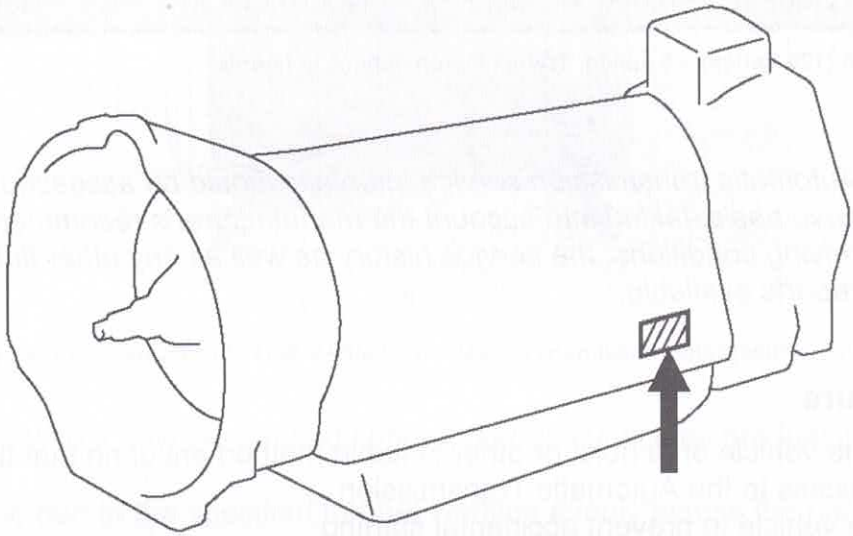

Diagram: 59: Toyota Prado (120 Series) – 5 speed, ID Plate location (source: Toyota)

Heat Exchanger location

The transmission heat exchanger is a pass through, incorporated into the radiator. These vehicles also utilise an external fluid cooler.

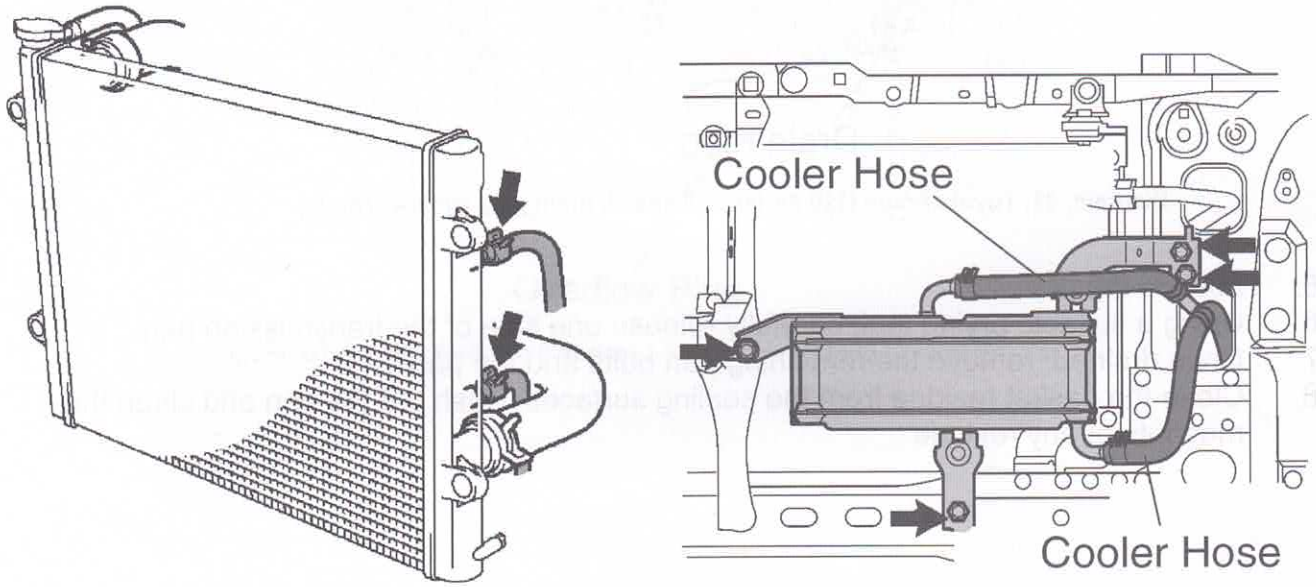

Diagram: 60: Toyota Prado (120 Series) – 5 speed, heat exchanger (left) and cooler (right) locations (source: Toyota)

TOYOTA PRADO (120 SERIES) – 5 SPEED continued...

Service Schedule

Vehicle	Inspect (km/yrs)	Normal Service (km/yrs)	Severe Service (km/yrs)
Toyota Prado (120 Series)	40,000km / 2yrs	Not Required	Not Specified

Table 33: Toyota Prado (120 Series) – 5 speed, Transmission service schedule

Note: *Automatic transmission service intervals should be assessed on a case by case basis, taking into account the manufacturer's recommendations, the driving conditions, the service history as well as any other fluid condition reports available.*

Service Procedure

1. Position the vehicle on a hoist or other suitable method ensuring that the vehicle is level to allow access to the Automatic Transmission
2. Isolate the vehicle to prevent accidental starting
3. Place a oil catch tray under the transmission (as close to the transmission as possible)
4. Remove the drain plug

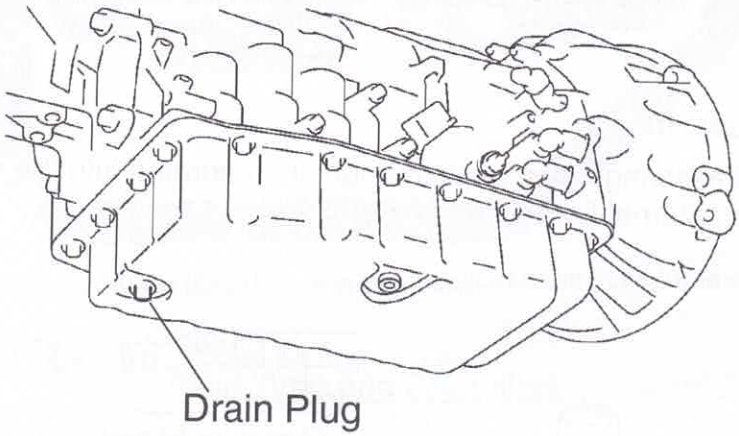

Diagram: 61: Toyota Prado (120 Series) – 5 speed, drain plug (source: Toyota)

5. Loosen the pan
6. Using a suitable prying tool, carefully release one side of the transmission pan
7. Once drained, remove the remaining pan bolts and the pan
8. Clean the gasket residue from the sealing surfaces, wash out the pan and clean the magnets of any residue

TOYOTA PRADO (120 SERIES) – 5 SPEED continued...

9. Remove the transmission filter and O-ring

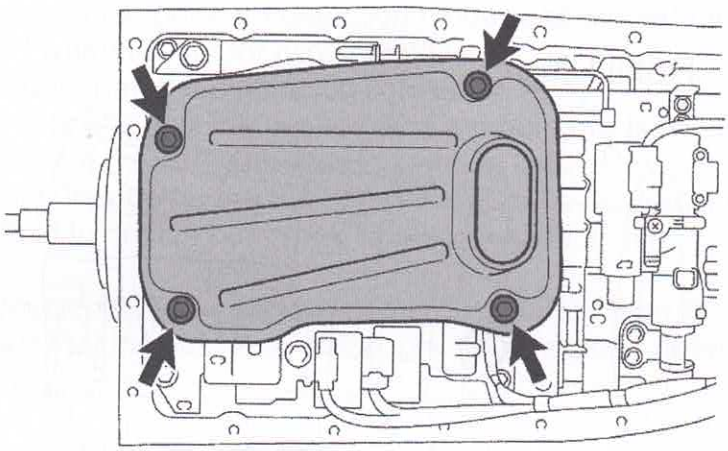

Diagram: 62: Toyota Prado (120 Series) – 5 speed, transmission filter (source: Toyota)

10. Fit the pan with a new gasket and tighten the bolts until they are just in contact with the pan
11. Tighten the pan to the specified torque, working evenly across the pan to avoid damage to the pan and gasket
12. Tighten the drain plug to the specified torque

Note: Toyota states that a new gasket should be fitted to the drain plug.

13. Remove the transmission fluid level (overflow) plug

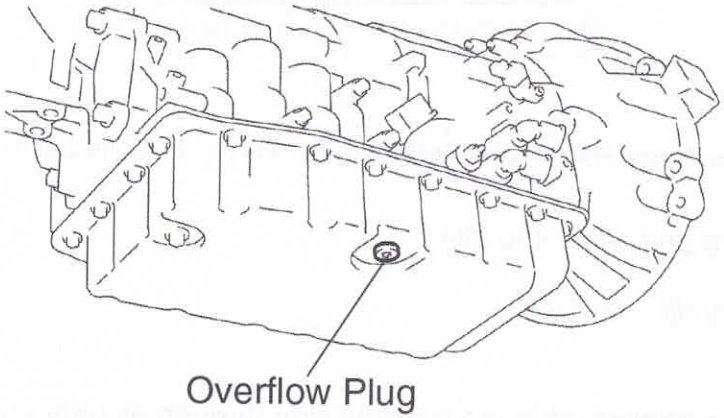

Diagram: 63: Toyota Prado (120 Series) – 5 speed, level plug (source: Toyota)

TOYOTA PRADO (120 SERIES) – 5 SPEED continued...

14. Add the specified fluid through the filler plug hole until fluid dribbles from the level plug hole.

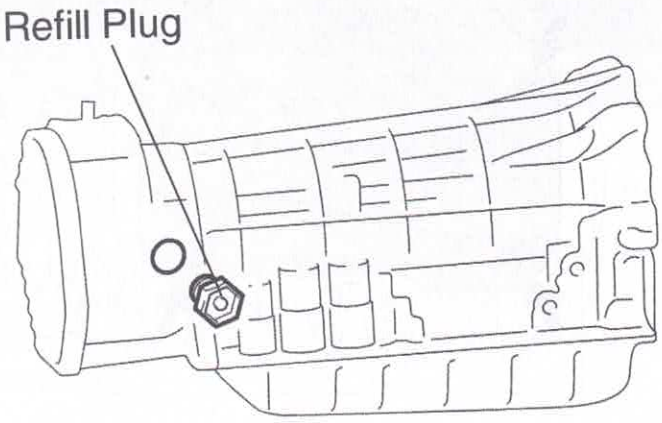

Diagram: 64: Toyota Prado (120 Series) – 5 speed, filler plug (source: Toyota)

15. Fit the filler and level plugs and tighten to the specified torque
16. Bridge terminals 4 and 13 of the diagnostic connector

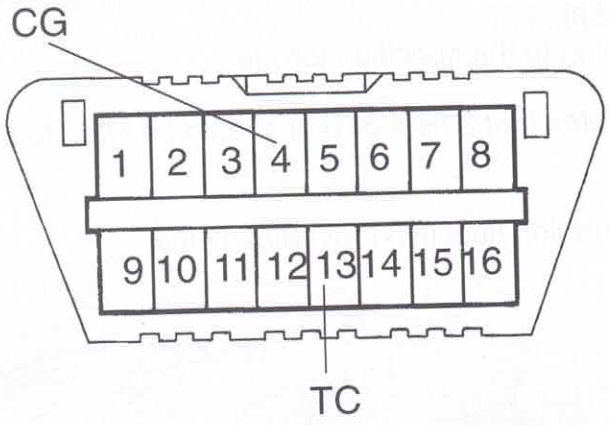

Diagram: 65: Toyota Prado (120 Series) – 5 speed, diagnostic connector (source: Toyota)

17. Start the engine and allow it to idle

Note: *Air conditioner OFF.*

18. With the brakes applied, shift the transmission through all gear selections. Pausing in each selection for a few seconds, return the shifter to the 'Park' position

TOYOTA PRADO (120 SERIES) – 5 SPEED continued...

19. Initiate fluid temperature detection mode by moving the shift lever between 'N' and 'D4' at least four times in six seconds
20. The initiation of fluid temperature detection mode is confirmed by the illumination of the "A/T OIL TEMP' warning light for two seconds
21. Remove the bridge from the diagnostic connector
22. Allow the engine to idle until the desired fluid temperature is achieved, this is confirmed by the illumination of the "A/T OIL TEMP' warning light
23. Place an oil catch tray under the transmission, remove the transmission fluid level plug and allow the fluid to dribble out until it slows to a slight trickle

Caution: The level tube holds approximately 3mL, if less than this amount dribbles out it is likely that the fluid level is too low. If this occurs, restart the procedure from step 13.

24. Tighten the filler and level plugs to the specified torque.

Note: Toyota states that a new O-rings should be fitted to the filler plug and a new gaskets should to the level plug.

25. Switch the Ignition OFF to end the fluid temperature detection mode.

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TOYOTA PRADO (120 SERIES) – 5 SPEED continued...

Specifications

Torque Settings

Item	Torque Specification
Transmission Filter	10Nm
Transmission Pan	4.4Nm
Drain Plug	28Nm
Level Plug	20Nm
Filler Plug	39Nm

Table 34: Toyota Prado (120 Series) – 5 speed, Transmission service torque specifications

Service Kit

Diagram 66: Toyota Prado (120 Series) – 5 speed, Service kit with rubberised cork gasket

Fluid Type and Quantities

Mobil ATF™ 3324 or other licensed equivalent

Procedure	Fluid Quantity
Service Fill	3.0L
Overhaul Fill	10.9L

Table 35: Toyota Prado (120 Series) – 5 speed, Transmission fluid quantities

Time Guide

Procedure	Time
Automatic Transmission Drain and Refill	1.2 hours
Automatic Transmission Service (inc. Filter)	2.4 hours

Table 36: Toyota Prado (120 Series) – 5 speed, Transmission times guide

Diagnosis

Auto-Tech's Diagnostic Process – Logical Flow chart was developed to assist workshops to achieve productive and profitable diagnosis of vehicle faults. For the purpose of this clinic this has been updated so that the 'Detailed Inspection' reflects the actual progress of automatic transmission diagnosis.

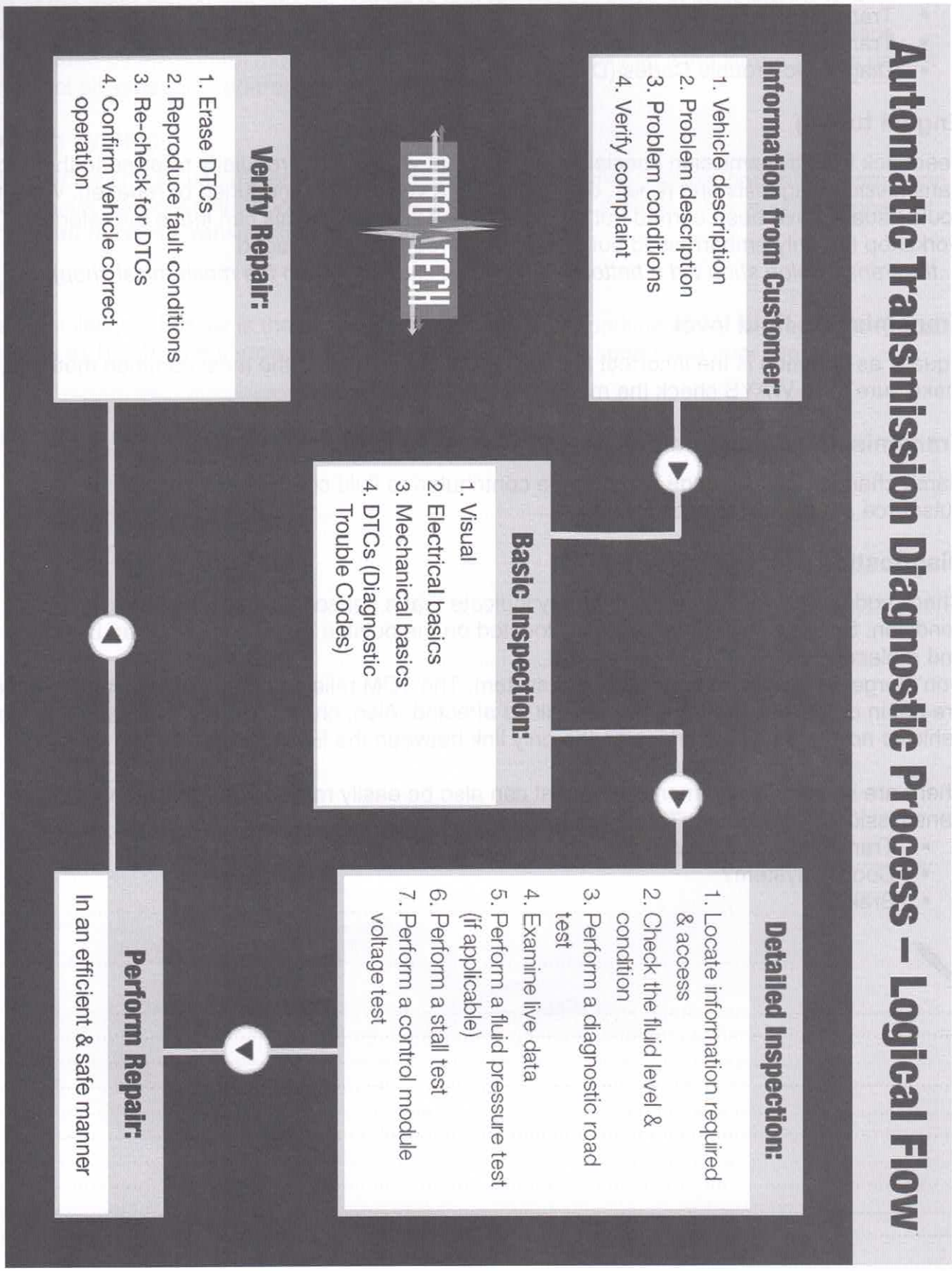
Automatic Transmission Diagnostic Process – Logical Flow
Information from Customer:
1. Vehicle description
2. Problem description
3. Problem conditions
4. Verify complaint
Basic Inspection:
1. Visual
2. Electrical basics
3. Mechanical basics
4. DTCs (Diagnostic Trouble Codes)
Detailed Inspection:
1. Locate information required & access
2. Check the fluid level & condition
3. Perform a diagnostic road test
4. Examine live data
5. Perform a fluid pressure test (if applicable)
6. Perform a stall test
7. Perform a control module voltage test
Perform Repair:
In an efficient & safe manner
Verify Repair:
1. Erase DTCs
2. Reproduce fault conditions
3. Re-check for DTCs
4. Confirm vehicle correct operation
AUTO TECH

Diagram 67: Auto-Tech's Automatic Transmission Diagnostic Process – Logical Flow

BASIC INSPECTION

When it comes to diagnosing faults on an automatic transmission there are a number of checks that should be carried before you sub-let the job out to a transmission specialist.

Failing to check these could leave you a little red faced!

- Engine tuning and operation
- Transmission fluid level
- Transmission fluid condition
- Diagnostic Trouble Codes (DTC's)

Engine tuning

Feedback from transmission specialists reports that vehicles are regularly referred to them for transmission diagnosis and repair, only to have the vehicles engine tuned or repaired. Work that could usually have been carried out by the referring workshop. This can leave the referring workshop not only embarrassed but also have its reputation damaged
(...the transmission shop did a better job of engine diagnosis than the mechanical shop).

Transmission fluid level

Equally as common is the incorrect fluid level. We have covered the most common methods, make sure to ALWAYS check the manufacturers specifications.

Transmission fluid condition

Harsh changes and slippage can both be contributed to fluid condition, there is no need to outsource a transmission service.

Diagnostic Trouble Codes (DTC's)

Check codes with your Scan Tool. It may indicate that a sensory system is causing the condition. Speed Sensors are regularly located on the outside of the case and can be tested and replaced easily.
Don't forget to check the engine control system. The TCM relies on many engine inputs, if these are not in order then the transmission will be affected. Also, check for CAN-BUS faults as most vehicles now rely on networking as the only link between the ECM and the TCM.

There are some less common issues that can also be easily rectified and may impact on transmission performance. These include:

- Transmission fluid type?
- Cooling system?
- Brakes?

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BASIC INSPECTION continued...

Transmission fluid type

If the customer has had transmission repair, service or just a top up carried out it is possible that the incorrect fluid has been used. The need for specialised fluids in modern transmissions has been addressed (see *ATF Type* on *Page 26*).
One of the most critical operational factors is that the transmission control system is programmed to operate to a very specific fluid specification. The transmission operations commanded by the control module are carried out hydraulically so if the wrong fluid is used it can affect all aspects of operation.

Cooling system

ALL vehicles should use either a standalone or internal radiator heat-exchanger (transmission fluid coolers are considered optional). If the engines cooling system is not working properly it can therefore cause transmission temperature issues.

Brakes

The least likely of this list is the possibility for the brakes or parking brake to drag. This typically presents as harsh up and down-shifts particularly in the low speed and gear range.

DETAILED INSPECTION

Now that the basic items have been addressed it is time to move on to the more detailed inspection. Depending on the results, these tests will outline whether the fault or repair can be addressed by a typical automotive workshop or whether it will require the assistance of a specialist automatic transmission repairer.

To assist in the detailed inspection Auto-Tech has developed an 'Automatic Transmission Diagnostic Worksheet' and it is provided in the back of this manual so that it can easily located and photocopied. Using this will help pinpoint faults and minimise diagnostic time.

The logical steps of automatic transmission diagnosis are:

- Locating the required information
- Diagnostic road test
- Pressure test
- Stall test
- Electronic Diagnosis

Locating the required information

There is a lot of technical information provided to assist you in diagnosis. This is also true for automatic transmissions. Information such as:

- Detailed operational descriptions
- Wiring diagrams
- Hydraulic schematic diagrams
- TCM voltage tables
- Component testing procedures
- Scan tool data lists
- Power flow diagrams

This is to name but a few. There is one item that is specific to automatic transmissions and on average is more beneficial than any of these:

- Shift Matrix

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DETAILED INSPECTION continued...

Shift Matrix

Sometimes the shift matrix is provided as you can see in *Table 9* and sometimes provided as separate Solenoid and Clutch Matrix's. Either way these provide an easy to understand graphical representation of which solenoids and elements are involved in any particular shift sequence.

Position	Solenoids						Elements					
	SLT	S1	S2	S3	S4	TC	C1	C2	B1	B2	B3	OWC
P		ON										
R					ON					ON	ON	
N		ON										
D6	ON		ON	ON				ON	ON			
D5	ON		ON		ON			ON			ON	
D4	ON	ON	ON				ON	ON				
D3	ON	ON					ON				ON	
D2	ON	ON		ON	ON		ON		ON			
D1		ON					ON					H
L1		ON				ON	ON			ON		H

Table 37: Toyota U660E Shift Matrix

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DETAILED INSPECTION continued...

Principles
Knowing which components are related to any particular function allows the technician to cross reference a particular fault within a vehicle to see if any one of these components might be responsible.

Now, before we jump into an example it is vital to understand how the solenoids control the elements. Because while there are lots of connections that can be made between certain solenoids and elements, there are a number of contradictions.

The fact is that the solenoids do not control elements (well not directly anyway). The solenoids control the valves in the valve body and the valves in turn control the elements.

The example shift matrix provided (see *Table 9*) is from a Toyota U660E 6 speed found in front wheel drive Camry's as well as some Lexus vehicles. It consists of one solenoid (SLT) dedicated to pressure control only and five linear control solenoids. The fifth linear control solenoid is named TC for Torque Converter, however this solenoid is used both for the lock-up clutch and for the B2 brake when the gear selector is placed in Low (1).

DETAILED INSPECTION continued...

Principles

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DETAILED INSPECTION continued...

The six solenoids in the lower valve body (see *Diagram 21*) control a total of 16 valves in the mid and upper valve bodies (see *Diagram 22*) which are in control of the two clutches and three brakes (as set out in *Table 9*) plus the torque converter lock-up clutch.

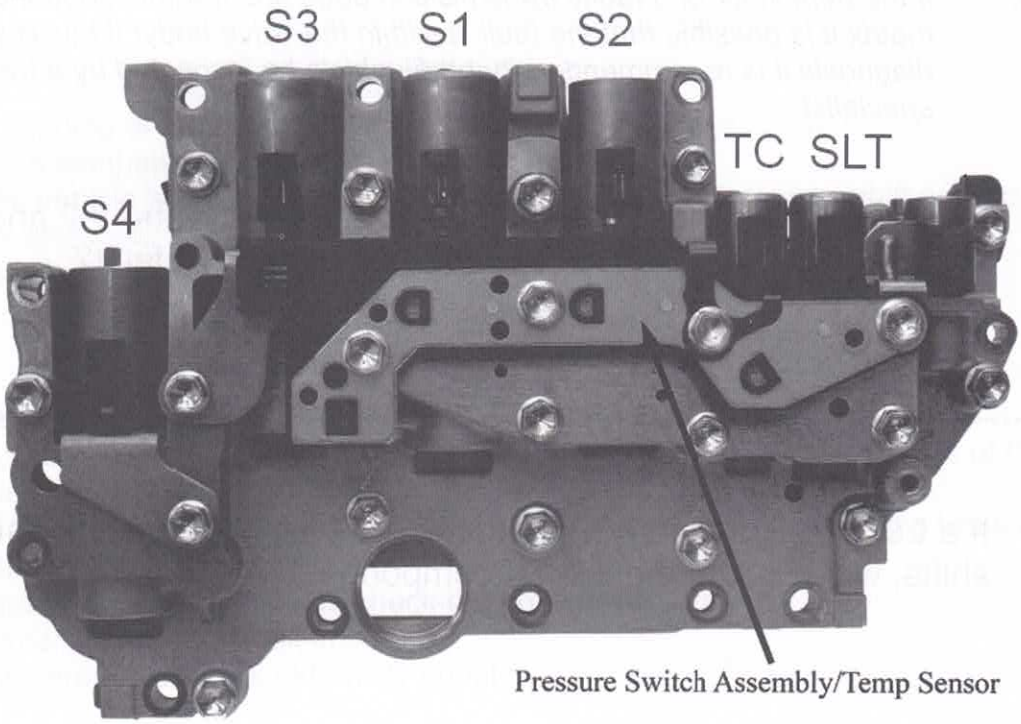

Diagram: 68: Toyota U660E Lower Valve Body (image source: Gears)

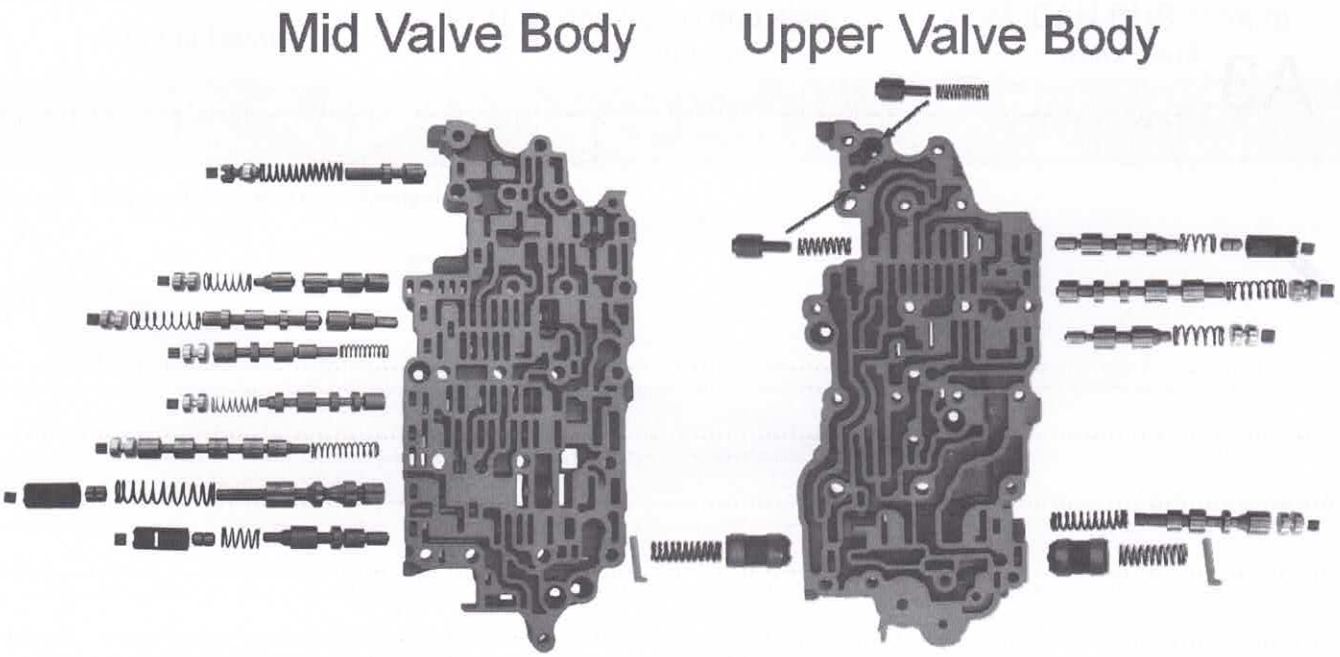

Diagram: 69: Toyota U660E Mid & Upper Valve Bodies (image source: Gears)

DETAILED INSPECTION continued...

Application
Using the shift matrix provided (see *Table 9*) identify which component could be responsible for each scenario.

Note: *If the behaviour of a faulty transmission does not fit within sequences of the matrix it is possible that the fault is within the valve body! If this is your diagnosis it is recommended that the vehicle be inspected by a transmission specialist.*

Q1: If a transmission has a shift flare that effects only the 1-2 and 4-5 shifts, which is the most likely component to be at fault?

A1: _____

Q2: If a transmission has a shift flare that effects only the 2-3 and 4-5 shifts, which is the most likely component to be at fault?

A2: _____

Q3: If a transmission has a shift flare that effects only the 1-2, 2-3 and 3-4 shifts, which is the most likely component to be at fault?

A3: _____

DETAILED INSPECTION continued...

Diagnostic road test

In the back of your manual you will find an Automatic Transmission Diagnostic Worksheet. This should be used on a road test in conjunction with a Scan Tool to create a complete picture of transmission operation.

Procedure

1. Engine running at normal operating temperature
2. Connect a compatible scan tool and initiate live data
3. Drive the vehicle in a manner that allows for the transmission to up-shift and down-shift through each gear under the same conditions as described by the customer
4. Reach cruising speed and check for torque converter lock-up.

Analysis

- While driving, have an assistant monitor then live data.
- Compare the shift timing between the scan tool data and the physical shifts of the transmission (see *Table 10*)
- Many TCM's monitor the speed sensors to determine how it takes for the transmission to shift ratio after the command.
- If you are chasing a harsh shift, check the pressure command.
  - Normal command – look internally
  - High command – look externally (inputs)

Condition	Timing	Area of Fault
Shift is smooth and without flare	TCM command and shift simultaneous	No Fault
Shift is harsh	TCM command and shift simultaneous	TCM, CAN-BUS or input sensor fault
Shift is harsh	Delay between command and shift	Transmission Fault

Table 10: Diagnostic Road Test - Analysis

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DETAILED INSPECTION continued...

Pressure Test

If your transmission pressure gauge is lying dormant in the bottom of the diagnostic cupboard, it is time to wipe off the dust and hang it back up on the peg board! Most transmissions do not use a fluid pressure sensor, the control module simply assumes that the pressure requested of the pressure control solenoid has been achieved.
We all know that to assume will make an ASS of U and ME!

Diagram 23 is a right hand side view of a Chrysler RFE series transmission (fitted to various Chrysler & Jeep models in Australia). It is one of a rare few to utilise a Line Pressure Sensor for accurate closed loop monitoring of the Line Pressure.

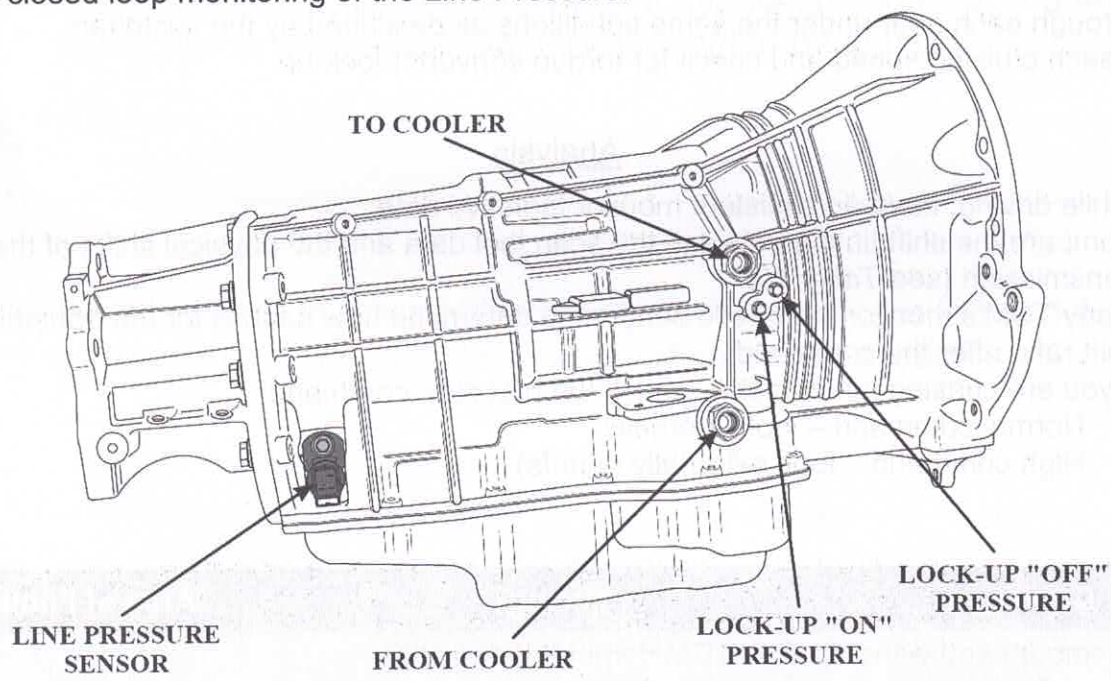

Diagram: 70: Chrysler FRE series transmission (image source: Chrysler)

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DETAILED INSPECTION continued...

Line Pressure

Measure the line pressure manually and compare it to the command – they should be the same. If they are not then a lack/loss of control pressure might be your root cause.

The line pressure tap is usually located in the fluid circuit immediately after the line pressure control solenoid. This represents the maximum fluid pressure available to the hydraulic control system. It will help to keep in mind that the main line (orifice) is large in diameter and has a large flow rate, this means that small leaks will have little effect of the reading.

The line pressure check is normally carried out with a 0-3500kPa (0-35 bar) pressure gauge. The line pressure check will confirm that the pump and pressure regulator are delivering sufficient pressure for the transmission to function.

Typical signs of low fluid pressure are:

- Slippage
- Slip-bump (where the shift slips and then engages harshly)
- Losing gears on deceleration

DETAILED INSPECTION continued...

Control Circuit Test

Fewer manufacturers are providing a full set of diagnostic taps. This largely stems from the manufacturers desire to replace the transmission as a single unit (most manufacturers only provide either a full transmission or mechatronic only as spare parts). Fortunately transmission specialty suppliers such as Repco supply many of individual components (and a lot of these come directly from the transmission manufacturer).

Unlike the line pressure test, the diagnostic pressure test ports use much smaller orifices, in addition they are actuating relatively large actuators. What this means is that a leaking actuator although unlikely to be noticed on line pressure will have a significant difference on its specific diagnostic tap.

As a rule the individual circuit pressures should not fall more than 10% of the line pressure.

You will need to access vehicle specific information to carry out this procedure. If you cannot find the data in Autopedia contact the help desk.

DETAILED INSPECTION continued...

Results

Circuit pressure ≥10% below line pressure:
Leak within the valve body

Gauge fluctuates on line pressure test:
Air bleed on pickup, filter or lip seal or damaged/worn pump

Harsh Shifts
When trying to diagnose harsh shifts with a pressure gauge the broad parameters provided by manufacturers means you do not have the detail required to determine if pressure is a concern. The best way to identify this type of issue is to monitor the operation of a known good vehicle. Watch the gauge/s as each shift occurs, take note of how high the pressure rises and settles at each shift. Then compare them to the vehicle with the complaint. Over time and practice you'll learn to identify what is normal and what is not.

Caution: Don't get caught out!

- *If a transmission has been rebuilt with non-genuine clutches and brakes these may be the cause of the shift problem.*
- *Make sure it is using the correct fluid.*

As you can see, the faithful pressure gauge is still a useful and worthwhile piece of equipment.

DETAILED INSPECTION continued...

Stall Test

Stall tests are as relevant today as they were when the torque converter as we know it reached mass production in the 1950's (although Australia did not see many auto's until the 60's). The stall test can identify Torque Converter issues quickly and without the need of specialised equipment.

The stall test:

- Can identify torque converter faults
- Can identify transmission brake and clutch faults

Before carrying out a stall test ensure that all safety procedures have been addressed.

Examples of safety procedures include:

Chock the wheels

Apply the brake firmly

Limit each stall test to 5 seconds

Keep bystanders well clear

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DETAILED INSPECTION continued...

Procedure

Caution: The stall test should not be carried out until after the line pressure test. Carrying out a stall test on a transmission with a reduced ATF supply can cause irreparable damage to the transmission.

1. Engine running at normal operating temperature
2. Wheels chocked with parking brake ON
3. Apply the brake firmly with your left foot
4. Select [R] and depress the accelerator pedal until maximum RPM is reached – record stall speed
5. Shift into [N] and run engine @ 1,500 RPM for one minute
6. Repeat steps 4 & 5 for [D] and [L]

Results

Low stall speed

- Engine fault – lacking power
- Torque Converter failure

High stall speed

- Low fluid pressure, carry out pressure test
- Slipping clutch, use matrix to identify element

Note: If the stall speed is high in [D] but is normal in [L]. The one way clutch is slipping.

DETAILED INSPECTION continued...

Electronic Diagnosis

Electronic diagnosis using a Scan Tool, Multi-meter and/or Oscilloscope is no different for transmissions than engines or any other system. Follow good diagnostic practices, starting with the basics. For vehicles fitted with a PCM or an externally mounted TCM, extended diagnosis is relatively straight forward.

For vehicles fitted with a mechatronic unit, diagnosis is more difficult. Although original equipment manufacturers (OEM's) will often only supply a new mechatronic unit as a whole, it may still be possible to diagnose, source and replace individual components. If you suspect that a fault lies within the mechatronic unit Auto-Tech recommends seeking the assistance of an experienced transmission specialist.

In reaching this point on the diagnostic logical flow, you should have already check for DTC's and connected the scan tool as part of the diagnostic road test to monitor the live data. Don't put it away yet, it may still be of use.

The following topics list the tests recommended for a specific component or circuit.

DETAILED INSPECTION continued...

Inputs

ECM and CAN-BUS

The transmission control system relies on a wealth of signals from the engine (and various other) control systems. These signals include but are not limited to:

- Air intake
- Crankshaft position
- Throttle position
- Engine temperature
- 4WD status (if applicable)
- Brake status
- Cruise control status

The communication between the ECM and the TCM can be tested by:

- Checking DTC's with a scan tool
- Monitoring the operation of CAN-BUS network with an oscilloscope

Speed Sensors

The majority of transmissions utilise externally mounted inductive sensors, however transmissions using a mechatronic tend to incorporate these into the control module.
As with any speed sensor these can be tested by:

- Checking DTC's with a scan tool
- Disconnecting the connector and measuring the sensor circuit resistance
- Monitoring the output signal with an oscilloscope

ATF Temperature Sensor

The operation of the ATF temperature sensor can be checked by:

- Checking DTC's with a scan tool
- Carrying out a TCM voltage test
- Comparing the live data value with actual temperature measured with an infrared thermometer
- Disconnecting the pass through connector and measuring the sensor circuit resistance
- Monitoring the output signal with an oscilloscope

Transmission Range Switch

The transmission range switch can be incorporated into the shift lever assembly or mounted to the shift position shaft on the side of the transmission.
The transmission range switch can be tested by:

- Checking DTC's with a scan tool
- Carrying out a TCM voltage test in each selector position
- Disconnecting the connector and measuring the circuit resistance in each position

DETAILED INSPECTION continued...

Outputs

Solenoids

The solenoids can be easily tested on most transmissions. For vehicles fitted with a mechatronic unit testing of the individual solenoids will require the removal of the transmission pan and ATF.

- Checking DTC's with a scan tool
- Carrying out a TCM voltage test
- Carrying out a voltage drop test to the TCM
- Monitoring the output signal with an oscilloscope (particularly those using PWM)
- Disconnecting the pass through connector and measuring the solenoid resistance (if applicable)
- Removing the oil pan and testing the individual solenoid resistance

Automatic Transmission Diagnostic Worksheet

Customer:	Vehicle Make:	Model:	Month/Year:	Registration #
VIN:		Odometer:		
Service Advisor:	Technician:		Date:	

Complaint: _____

_____

_____

Repeat Complaint: ❑No ❑Yes, details:_____

Conditions: (× = NO ✓ = YES)

❑Smooth surface	❑Dry surface	❑Heavy traffic
❑Rough surface	❑Sealed surface	❑Light traffic
❑Wet surface	❑Unsealed surface	❑Open road

Occurrence: (× = NO ✓ = YES)

❑Always	❑Throttle position _____ %	❑A/C status ON / OFF
❑Intermittent	❑Braking / Cornering	❑Towing
❑Eng/Trans – HOT / COLD	❑Cold Weather (< 0°C)	❑INCLINE / DECLINE
❑Engine speed _____RPM	❑Normal Weather (0-30°C)	❑Gear _____
❑Vehicle speed _____km/h	❑Hot Weather (30°C >)	❑Replicate complaint

Noise: (× = NO ✓ = YES)

❑Buzz	❑Whine	❑Clunk	❑Rattle
❑Moving	❑Stationary	❑In gear:_____	❑In PARK / NTRL

	Inop.	Early	Delayed	Harsh	Slip	Shudder	Stalls
Drive engagement							
Reverse engagement							
1-2 Upshift							
2-3 Upshift							
3-4 Upshift							
4-5 Upshift							
5-6 Upshift							
6-7 Upshift							
7-8 Upshift							
8-9 Upshift							
9-8 Downshift							
8-7 Downshift							
7-6 Downshift							
6-5 Downshift							
5-4 Downshift							
4-3 Downshift							
3-2 Downshift							
2-1 Downshift							
Torque Convertor Lockup							

Place an × for all relevant

Automatic Transmission Diagnostic Worksheet

Replicate Condition: ❑No ❑Yes, details: _____

Engine Tuning: ❑Normal ❑Other: _____

Fluid Level: ❑Correct ❑Low ❑High Fluid Condition: ❑Normal ❑Other _____

DTC: _____ ❑Current ❑History Details: _____
Test Results: _____

Diagnosis: _____

DTC: _____ ❑Current ❑History Details: _____
Test Results: _____

Diagnosis: _____

DTC: _____ ❑Current ❑History Details: _____
Test Results: _____

Diagnosis: _____

Fluid Type: ❑Correct ❑Other _____

Engine Cooling: ❑Normal ❑Other _____

Stall test:
■ Specification: _____RPM ■ Result: _____RPM ■ Pass: ❑YES ❑NO

Line Pressure:

	Scan Tool	Gauge	Specification
Park			
Reverse			
Drive			

Where available

Notes: _____

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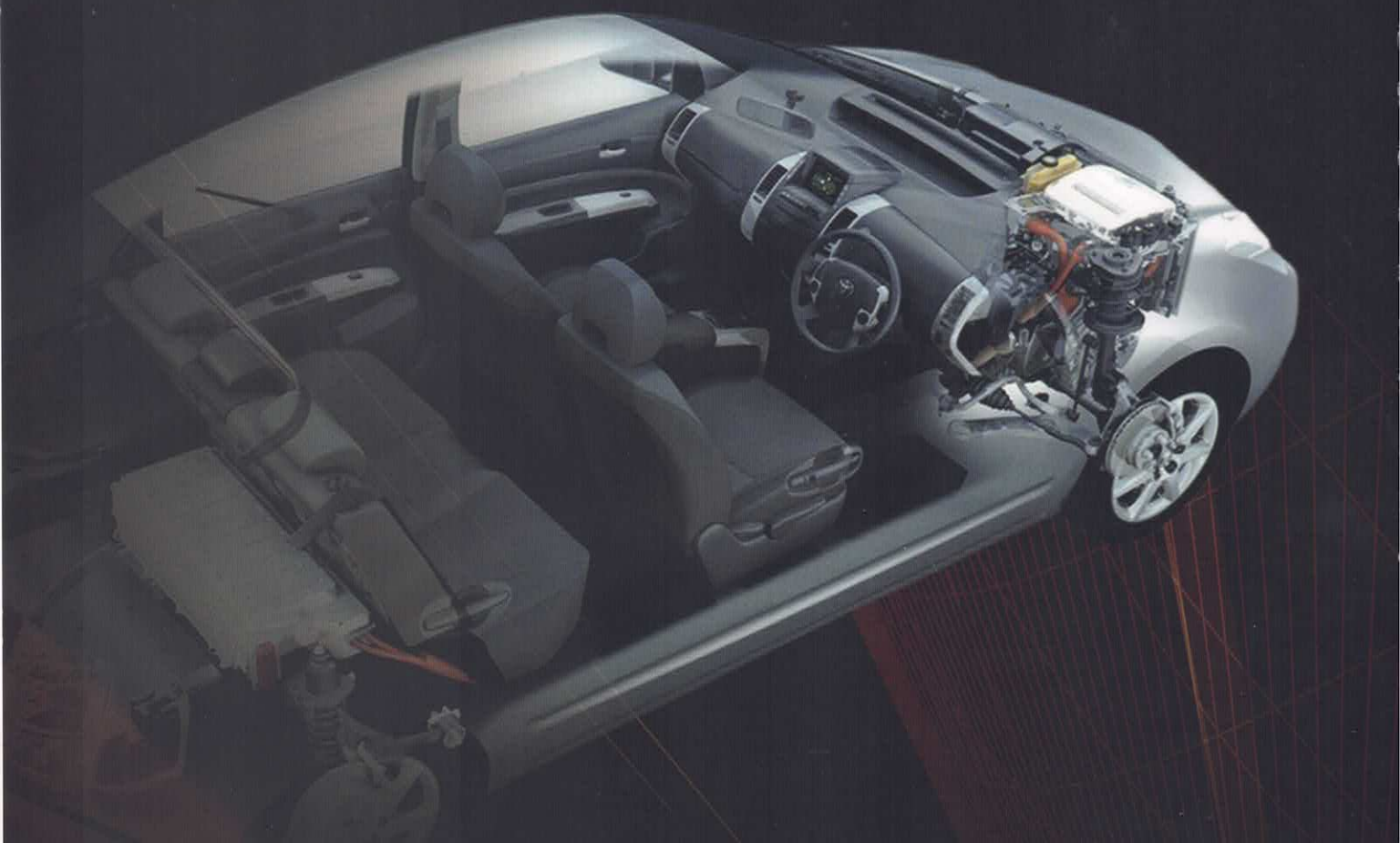

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